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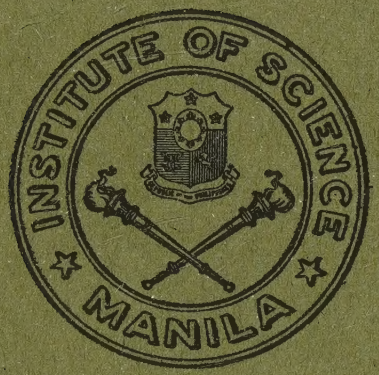

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COMPARATIVE RESISTANCE OF NATIVE WITH TWO IMPORTED BREEDS OF CHICKENS TO ASCARIDIA LINEATA (SCHNEIDER)

By LOPE M. YUTUC and DOMINADOR K. OYZON
Of the College of Veterinary Medicine, University of the Philippines

In some of the results on the investigations of resistance to helminthic infection it has been demonstrated that certain breeds or strains are naturally more resistant than others in the same species of animals. For instance, Miller (1908) observed that purebred Zebu cattle in Trinidad are more resistant to the ravages of strongyles than other breeds of cattle. In the observation of Gonzalez and Lago (1923) on swine improvement in the Islands, it was disclosed incidentally that native swine are more resistant to *Stephanurus dentatus* than did the imported and improved breeds of pigs. The first experimental evidence of breed difference in resistance to helminthic infection, however, appeared to have been demonstrated for the first time in chicken (Ackert et al., 1933; 1935). In general, the heavier breeds of birds were more resistant to *Ascaridia lineata* than the lighter breeds of birds were. Among sheep, lowland breeds such as the Border Leicester, on an overcrowded pasture, were more susceptible to the effect and more heavily parasitized than the Cheviot sheep (Cameron, 1935). In chicken, strain resistance to nematode infection has been noted in the Minorca and White Leghorn breeds (Ackert et al., 1934; 1936).

In this present investigation, report is made on the results obtained in the comparative study on the natural resistance of native chicken to the round worm, *Ascaridia lineata,* against that of two imported breeds, the White Leghorn and the New Hampshire. As far as the writers are aware, this is the first experimental investigation on innate helminthic resistance in the Islands.

MATERIALS AND METHODS

Purebred White Leghorn and New Hampshire, and native chickens were used in this study. In the first experiment, 40 native eggs were incubated at a local hatchery. Out of these eggs only 32 chicks were obtained. Along with these, twenty-six White Leghorn and 25 New Hampshire chicks were obtained as day-old chicks. Of these, only 18 natives, 12 Leghorns and 6 Hampshires reached the close of the experiment. Deaths registered due to an undiagnosed disease were 10 natives, 11 Leghorns and 16 New Hampshires. The rest died of various accidents. One native chick which died 16 days after infection was found to harbor worms. The number of worms obtained was noted and included in the computation for the mean number, but not in the computation for the mean length. The other post infection deaths which occurred mostly about a week after the infection did not show any worm on being posted.

Thinking that the New Hampshire group in the first experiment would not furnish enough data, a second experiment was performed using only native and New Hampshire chicks to supplement the deficiency. Accordingly, fifteen day-old native and 17 New Hampshire chicks were used. Of the native group, one died prior to infection and 4 after infection, including one killed by a dog. Postmortem examination of the post-infection deaths revealed no worm. Of the Hampshire group, 2 died before having been fed the ova.

The chicks were reared in a wire cage which measured 1 meter by 2 meters by 0.3 meter and provided with legs 0.6 meter high. Attached to one end of the cage was a compartment 1 meter by 0.3 meter. This was made of plywood all around except that side facing the enclosure, which was left open. Inside, two electric bulbs were placed to keep the chicks warm. On the other end of the cage was another compartment made of an empty milk box with an electric bulb used primarily for isolating weak and sick chicks.

The first batch of chicks were fed with "Centennial" chick starter mash, a U. S. commercial product, during the first week. After this was consumed, another brand, "Ful-O-Pep", was used. The latter brand of chick starter and triple duty was used for the second experiment. Sulfamethazine solution was given to both sets of chicks: to the first, at the height of the disease, when they were 8 days old; and to the second, when they were 9 days old, when one native bird died of coccidiosis.

The nematode eggs for infecting the chicks were secured from adult live worms recovered from native chickens. The method

of preparing the egg culture was adopted from Ackert (1931), which is in brief as follows: The tip of the worm was excised and the internal contents pressed out into a sterile petri dish. The uteri were isolated and transferred to another sterile dish. Samples of the eggs on the enlarged portions of the uteri were examined under the microscope to determine their fertility. Those portions found to contain fertile eggs were then transferred to a final sterile dish and chopped very finely to liberate the eggs. The eggs were covered with sterile distilled water and 8 drops of 2 per cent formalin added to discourage fungus or bacterial growth. The culture was placed in the bacteriology inoculating room in which the temperature was 27 to 30 degrees centigrade which was found to be ideal. Cultures used for the first and second experiments were 27 and 30 days old, respectively.

The chicks were infected when they were 12 days old. Each was given 50 (plus or minus 5) eggs, as Ackert et al. (1931) found this number suitable for works on comparative resistance of the hosts. The dose was prepared by loosening the eggs from the bottom of the dish and placing a few drops in a small bottle containing glass beads and water. The bottle was shaken. This was found necessary in order to break up the clusters of eggs and at the same time suspending them evenly. The eggs were placed on a slide and were counted with the aid of a microscope equipped with a mechanical stage. The drop of water containing the correct number of eggs was wiped off the slide with a small piece of filter paper. This was folded and formed into a pellet and with a pair of forceps was placed in the esophagus and forced down into the crop with the fingers. The worms were allowed to develop for 3 weeks. At this time the worms had detached themselves from the intestinal mucosa and were then found free in the lumen (Ackert, 1931).

On the 21st day of parasitism, the chicks were decapitated and the worms collected in the following manner: The small intestine was excised from the rest of the organs and divided into three segments. At first, the intestine was opened by scissors and the contents were scraped into a glass receptacle; but with the use of scissors some worms were cut, so another method was devised. The tip of a syringe, filled with water, was inserted into one end of the segment and the water forced through it. The worm contents this time were received in a glass jar, transferred to a petri dish, counted and preserved in 10 per cent formalin until the time for measurement. To make sure no worms were left in the intestine, this was opened afterwards.

In measuring, the worms were pressed between two glass plates and placed in an epidiascope [1] and projected to 10 times magnification on a Manila paper screen. The image was traced with colored pencil, and from these tracings direct measurements were made with a gear of known calibration.

The criteria adopted in this study are the average number of worms and their average length for each breed of chicken.

EXPERIMENTS AND RESULTS

Experiment 1.—From 19 native chicks, including one which died and was autopsied, a total of 39 worms was collected. The range, as seen in Table 1, was zero to 6 worms. Of the 19 chicks, 5 failed to catch the infection. As shown in Table 2, the mean number for this group was 2.05 worms per bird, and the mean length of the worms, 21.41 mm. From 12 Leghorns, the range was 7 to 26 from a total of 180 worms obtained, and the mean number and mean length were 15 worms per bird and 30.54 mm., respectively. A total of 104 worms was collected from 6 Hampshires which had a range of 15 to 20. On computation, a mean number of 17.33 worms per bird and a mean length of 29.91 mm. were obtained.

TABLE 1.—*The number of worms obtained from each chicken*

Chicken number	Experiment 1			Experiment 2	
	Native	Leghorn	Hampshire	Native	Hampshire
1	0	8	16	4	18
2	2	7	20	0	11
3	3	26	17	0	9
4	1	20	19	0	8
5	3	24	15	1	10
6	2	15	17	3	7
7	2	8	-------	0	13
8	0	20	-------	9	12
9	0	14	-------	4	23
10	1	13	-------	2	17
11	4	11	-------	-------	9
12	0	14	-------	-------	6
13	6	-------	-------	-------	8
14	3	-------	-------	-------	14
15	5	-------	-------	-------	9
16	1	-------	-------	-------	-------
17	-------	-------	-------	-------	-------
18	0	-------	-------	-------	-------
19	5	-------	-------	-------	-------
Total	39	180	104	23	174

A difference of 12.95 was obtained between the mean number of the worms of the native and that of the Leghorn. This difference is 10.27 times its probable error. Since this difference

[1] Thanks is extended to the personnel of the Department of Veterinary Anatomy for the use and operation of the projecting apparatus.

TABLE 2.—*A biometrical comparison of the mean numbers and lengths of Ascaridia lineata from native and foreign breeds used in this study*

Expt.	Breed	Number of host	Number of worm	Mean number of worm	Stan. dev.	Diff. of means (D)	P. E. of diff. (E)
I	Native	19	39	2.05±0.2954	1.91	12.95	1,2608
	Leghorn	12	180	15±1.2258	6.29		
	Native	19	39	2.05±0.2954	1.91	15.28	0.5905
	Hampshire	6	104	17.33±0.5114	1.86		
II	Native	10	23	2.3±0.6120	2.86	9.3	1,023
	Hampshire	15	174	11.6±0.8192	4.70		

Expt.	Breed	Ratio $\frac{D}{E}$	Mean lenght of worm	Stan. dev.	Diff. of means (D)	P. E. of diff. (E)	Ratio $\frac{D}{E}$
I	Native	10.27	21.41±0.5653	3.45	9.13	0.628	14.54
	Leghorn		30.54±0.2736	1.21			
	Native	25.87	21.41±0.5653	3.45	8.5	0.7126	11.93
	Hampshire		29.91±0.4340	1.82			
II	Native	9.09	23.06±0.4973	3.53	5.07	0.7296	6.95
	Hampshire		28.13±0.5339	1.93			

is at least four times its probable error, it doubtlessly lies beyond the limits of experimental error, and hence, is not due to chance variation. And when the mean number of worms of the native is compared to that of the Hampshire, a difference of 15.28 becomes evident. This is 25.87 times its probable error, hence significant.

On the other hand, comparison of the mean lengths of the worm of the native and Leghorn groups gave a significant difference of 9.13 mm., which is 14.54 times its probable error. Taking the difference in the mean length of the worm of the native and of the Hampshire, we get 8.5 mm. This is also significant in that it is 11.93 times its probable error.

Experiment 2.—Ten native chicks which yielded 23 worms on autopsy had a range of worm burden from zero to 9. Moreover, of this number, 4 did not show infection on postmortem examination. The mean number obtained was 2.3 worms per bird, and the mean length of the worms was 23.06 mm. Of the 15 Hampshires killed, 174 worms were collected with a range of from 6 to 23. Computation gave a mean number of 11.6 worms per bird and a mean length of 28.13 mm.

Between the mean numbers of the worms of the native and the Hampshire, one finds a significant difference of 9.3, which is 9.09 times its probable error. And their mean lengths compared gave a difference of 5.07 mm. which is 6.95 times its probable error, and hence, in both cases significant.

DISCUSSION

Results of these two experiments, as shown in Tables 1 and 2, indicate that the native chickens are more resistant to the nematode, *Ascaridia lineata,* than either of the two foreign breeds. This is based not only on the parasitic burden and the length of the worms collected but also on the high proportion of negative take in the native chicks, being 9 out of 29 birds. In the imported breeds, all 33 chicks were positive to an infection of 50 eggs per bird. The general statement that certain breeds or strains are naturally more resistant to helminthic infection than others finds an added evidence in the above results. Although limted work has been done on the genetic explanation of natural resistance, it has been shown in the work of Curtis et al. (1933), on the different strains of rats, that the production of more tumors caused by *Cysticercus fasciolaris* in some rats was due to genetic difference in the host. Furthermore, Ackert et al. (1934) attributed the difference in the resistance of two strains of Minorca chickens to a genetic factor. Again, Ackert, Pratt and Freeman (1936) produced a strain of White Leghorn which was resistant, as well as one that was susceptible, to the common round worm of poultry. Gregory et al. (1940) also obtained evidence of genetic factor operating while working on sheep infected with strongyles. In view of the above, it is likely that a genetic factor also operates in the different resistances of the birds studied in this investigation.

In Experiment 1, it would be noted that more worms on the average, were obtained from the New Hampshire than from the White Leghorn and both had practically the same average length of worms. This might be explained in part by the fact that the resistance of the New Hampshire must have been lowered by the diseases that caused the chicks to die at the start of the experiment, it having the highest percentage of mortality, being 64 per cent as compared to 42 per cent for the Leghorn and 31 per cent for the native. Besides, only 6 Hampshires were used. It is probable that with a larger number of chickens used, shorter and lesser number of worms would be obtained. This is aptly supported by the result of Experiment 2, where the mean number of worms went down to 11.6 per bird instead of 17.33 and the mean length being 28.13 mm. instead of 29.91 mm. in the Hampshire group.

Since the mean number and the mean length of worms recorded in the present investigation in the foreign breed group

are decidedly greater than those reported by Ackert and his collaborators, it is not likely that tropical climate exerts a depressing effect upon the well-being of the chicken predisposing them to much heavier burden of parasitism than heretofore reported. This circumstance undoubtedly contributes to the significant difference in the degree of resistance of the two groups studied.

SUMMARY AND CONCLUSION

A study on the comparative resistance of native with two imported breeds of chicken to *Ascaridia lineata* (Schneider) is reported. On the basis of the experiments carried native chickens were found to be more resistant than both White Leghorn and New Hampshire breeds to the nematode.

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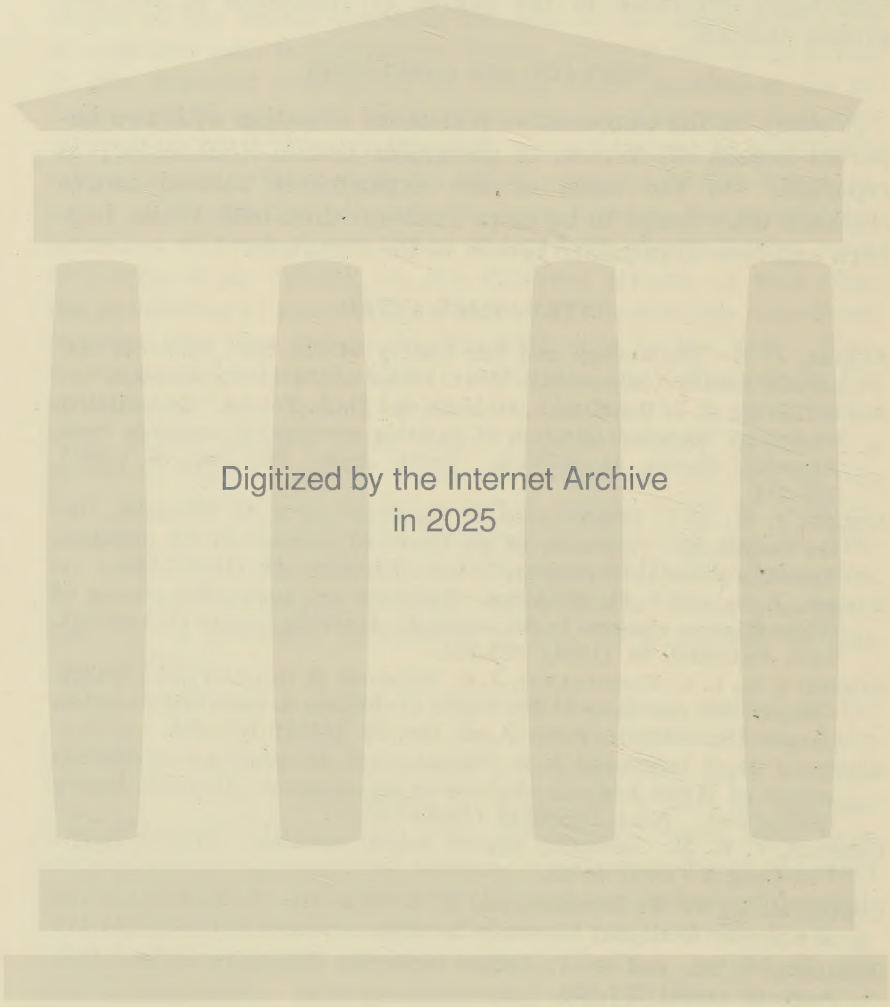

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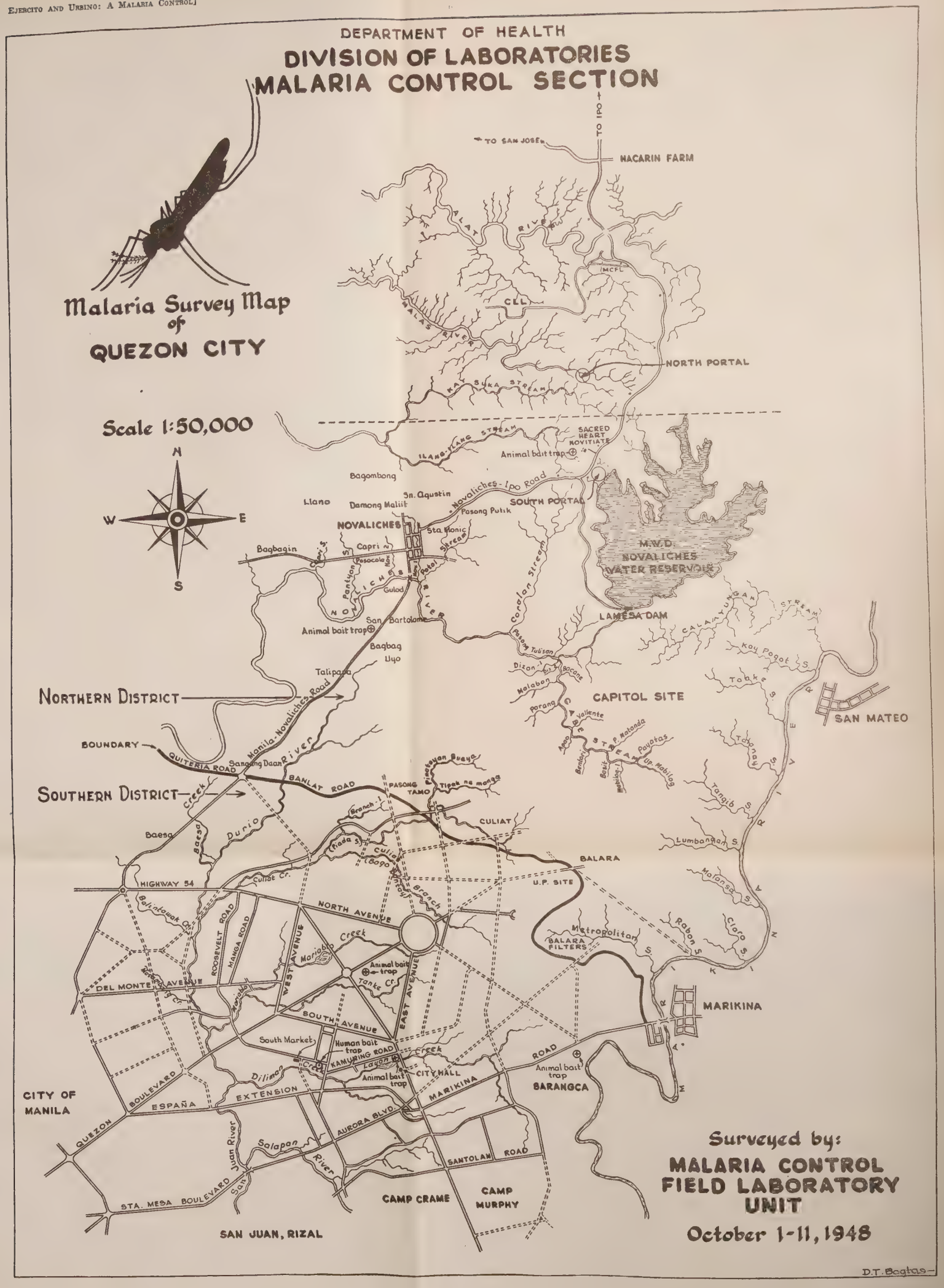

Map of Malaria Survey of Quezon City

A MALARIA SURVEY AND CONTROL IN QUEZON CITY

By Antonio Ejercito and Cornelio M. Urbino
Malaria Control Section, Division of Laboratories
Department of Health

TWO PLATES

Quezon City, (lat. MN 38, long. 121 E 00.4) comprises an area of 15,600 hectares east north east of Manila. It is a rolling country with an altitude ranging from 5 m. to 110 m. above sea level. The elevation of the northern half varies from 10 m. to 110 m., with an average of 64 m; while that of southern half ranges from 5 m. to 70 m., with an average of 41 m. Thus the city gradually slopes from north to south.

Quezon City has two distinct seasons: wet, from the later part of May to the early part of November, and dry, from the later part of November to the early part of May. The rainfalls (Table 1) reach their peaks in July and August, then gradually taper off toward the dry months. More than 50 per cent of the river branches dry up from February to May and thus reduce the breeding habitats.

Table 1.—*The total monthly rainfall and rainy days in La Mesa, Novaliches, Rizal, from 1939 to 1941*

Month	1939		1940		1941	
	Rainfall in mm.	Number of rainy days	Rainfall in mm.	Number of rainy days	Rainfall in mm.	Number of rainy days
January	15.60	7	57.20	5	32.30	6
February	0.50	1	29.70	1	0.80	1
March	29.00	3	1.27	1	3.30	1
April	79.50	11	59.00	4	20.80	1
May	147.61	17	164.00	11	51.50	10
June	193.65	21	336.00	24	383.39	20
July	577.10	25	763.20	29	419.00	14
August	544.20	29	416.80	27	612.90	27
September	330.20	20	394.20	21	299.30	22
October	250.30	17	184.20	15	225.58	19
November	123.10	19	31.10	9	46.44	13
December	215.30	9	35.00	7	54.10	3
Total	2,506.06	179	2,471.67	154	2,149.41	147

The northern part of the city has been selected as the site for the proposed capitol. At present, it consists of undeveloped cogonal land, traversed by the Novaliches and Marikina rivers and their tributaries, with prolific breeding of the malaria-

vector species. That section of the city is actually malarious. Malaria was so markedly prevalent from 1927 to 1929 in La Mesa, South and North Portal areas (1, 2, 3), which are located in the capitol site, that laborers and their families residing there for the Angat–Novaliches Water Projects of the Metropolitan Water District were seriously affected. The labor force had to be replenished continuously to finish the projects. At that time, it was not uncommon for transients in the region to contract malaria within a short time.

The southern part is fairly inhabited, with modern residential houses. It has been observed that in this section, malaria is not as bad as in the northern part, probably because the tributaries of San Juan and Marikina rivers traversing it afford relatively few habitats to *A. minimus* var. *flavirostris* (Ludlow), the known malaria transmitter.

It will be noted that Quezon City is composed of markedly rural as well as urban districts. It may therefore be considered as a miniature replica of the malarial picture in the Philippines, wherein the disease is prevalent in the rural areas, but not so in the urban.

The population of Quezon City as of 1948 was estimated at 107,977. The people are businessmen, professionals, employees, farmers, and laborers doing sundry jobs. There is no particular industry that is exceptionally conspicuous in the city.

The present paper is based on our studies on malaria and its control in Quezon City from 1938 to 1941 and in 1948.

METHODS OF STUDY

We divided the city for convenience into two districts by the Banlat road to Balara from where it is continued by dotted lines to the Marikina river (see map).

The Northern Rural District is bounded on the north by an imaginary line passing beyond the tip of the M.W.D. Novaliches Water Reservoir crossing the Novaliches–Ipo road at about Km. 24; on the south by aforementioned division land-marks; on the east by Marikina river; and on the west by Manila–Novaliches road.

The Southern Urban District lies south of the above-mentioned District, bounded on the east by Marikina river; on the west by the Manila–Novaliches road and the City of Manila; and on the south by San Juan, Rizal, Camp Crame, and Camp Murphy.

House to house canvasses in 1948 were carried out in four representative sections of Novaliches to determine the morbidity rates in the Northern Rural District. Parasite and spleen

rates from both the Northern Rural and Southern Urban District were obtained from well distributed classes of inhabitants in grouped areas. The morbidity rates in the Southern Urban District, however, were supplied by the office of the City Health Officer.

For anophelism, particular attention was directed to *A. minimus* var. *flavirostris*, the most efficient and well-known vector of malaria in the Philippines, without overlooking *A. maculatus* (Theobold) (4, 5) and *A. mangyanus* (Banks) (6) both already reported as malaria transmitters in this country.

Systematic surveys were made of all possible larval breeding habitats and imaginal day-resting places. Two animal-baited traps were erected: one in the Southern Urban District near the City Hall, and the other in the Northern Rural District at San Bartolome, west of the Capitol Site.

RESULTS AND DISCUSSION

THE NORTHERN RURAL DISTRICT

Observations on human host.—From the weekly house to house canvass in four representative sitios of Novaliches for malaria patients, the following malaria morbidity rates per 1,000 per annum were obtained during 1948:

1948	*Pasong Putik*	*Gulod*	*Sta. Monica*	*San Agustin*
January	750	216	702	750
February	937	309	585	937
March	812	340	702	812
April	562	278	820	562
May	625	309	585	625
June	500	186	410	500
July	687	216	410	417
August	500	247	468	371
September	500	186	351	324
October	688	371	585	556
November [a]	.....	.....	.....	.....
December	500	216	293	371

The records of the local Health Officer include mortality rates not for each of the foregoing sitios, but for the whole barrio of Novaliches. The mortality record from malaria per 1,000 population for 1948 was as follows:

January	0	May	0	September	0
February	0	June	0	October	0
March	1.2	July	0	November	0
April	1.2	August	0	December	2.4

Total ..... 4.8 per 1,000 per annum

[a] Canvasser was removed to an emergency assignment.

TABLE 2.—*The parasite and spleen surveys in the Northern Rural District (September 6, 1948 to October 13, 1948) and Southern District (September 28, 1948 to October 22, 1948), Quezon City*

Districts	Age groups	Number examined	Total positive blood	Rate	Total positive spleen[1]	Rate	Total gamete	Rate	Remarks
				Per cent		*Per cent*		*Per cent*	
Northern District:	Under 2 years	31	0	0	0	0	0	0	
Novaliches to San Bartolome	2 to 10 years	232	10	4.31	21	9.05	0	0	6 *P. vivax*
	Above 10 years	338	8	2.37	18	5.33	0	0	12 *P. falciparum*
	All ages	601	18	2.99	39	6.49	9	1.50	
Bagbag Talipapa to Sangandaan	Under 2 years	12	1	8.33	2	16.67	0	0	
	2 to 10 years	381	5	1.31	23	6.04	0	0	
	Above 10 years	381	5	1.31	17	4.46	0	0	6 *P. vivax*
	All ages	774	11	1.42	42	5.43	9	1.16	5 *P. falciparum*
Pasong Tamo Culiat to Balara	Under 2 years	4	0	0	0	0	0	0	
	2 to 10 years	205	2	0.98	8	3.90	0	0	
	Above 10 years	148	2	1.35	7	4.73	0	0	2 *P. vivax*
	All ages	357	4	1.12	15	4.20	4	1.12	2 *P. falciparum*
Totals	Under 2 years	47	1	2.13	2	4.26	0	0	
	2 to 10 years	818	17	2.08	52	6.36	0	0	
	Above 10 years	867	15	1.73	42	4.84	22	2.52	14 *P. vivax*
	All ages	1,732	33	1.90	96	5.54	22	1.27	19 *P. falciparum*
Southern District:	Under 2 years	46	0	0			0	0	
Cubao	2 to 10 years	958	0	0	0	0	0	0	
Kamuning	Above 10 years	1,164	2	0.17	0	0	0	0	2 *P. vivax* from
Diliman	All ages	2,168	2	0.09	0	0	0	0	Nueva Ecija
Balara Filter Compound	Under 2 years	24	2	8.33			1	4.1	
	2 to 10 years	45	1	2.22	2	4.44	1	2.0	
	Above 10 years	94	1	1.10	1	1.10	0	0	2 *P. vivax*
	All ages	168	4	2.45	3	1.84	3	1.80	2 *P. falciparum*
San Francisco del Monte San Jose Balintawak	Under 2 years	21	0	0			0	0	
	2 to 10 years	634	0	0	0	0	0	0	
	Above 10 years	629	0	0	1	0.16	0	0	
	All ages	1,284	0	0	1	0.07	0	0	
Totals	Under 2 years	91	2	2.20	0	0	0	0	
	2 to 10 years	1,637	1	0.06	2	0.12	0	0	
	Above 10 years	1,887	3	0.16	2	0.11	0	0	4 *P. vivax*
	All ages	3,615	6	0.16	4	0.11	3	0.08	2 *P. falciparum*

[1] The splenic enlargements according to degree 1, 2, 3, and 4 were 55, 30, 11, and zero, respectively.

Parasite and spleen surveys were made in three "group areas", namely, Novaliches to San Bartolome; Bagbag and Talipapa to Sangandaan and Baesa; and Pasong Tamo and Culiat to Balara. The results of these surveys were consolidated in Table 2, from which the following salient points may be deduced:

1. The total blood positives were found to be 14 *P. vivax* (Grassi et Feletti), or 42 per cent, and 19 *P. falciparum* (Welch), or 58 per cent. No *P. malariæ* (Laveran) was noted.
2. Evidence of autochthonous recent malaria, because of infections in infants.
3. Parasite and spleen rates in children from 2 to 10 years of age range from 0.98 per cent to 4.31 per cent, average 2.08 per cent and from 3.90 per cent to 9.05 per cent, average 6.36 per cent, respectively; in subjects above 10 years of age, from 1.31 per cent to 2.37 per cent, average 1.73 per cent and from 4.46 per cent to 5.33 per cent, average 4.84 per cent, respectively.
4. There is an apparent progressively gradual reduction in positive bloods and spleens from Novaliches (most northern and highest part of the city) to Balara (eastern outskirt of the southern part).
5. In all age groups, summary findings show 1.90 per cent and 5.54 per cent for positive blood and spleen, respectively.
6. In "group areas" in the North Rural District, the gametocyte rates were 1.50 per cent, 1.16 per cent, and 1.12 per cent, respectively, with a general average of 1.27 per cent. Of the total 33 blood positives, 22 or 67 per cent were of gametocyte and 11 or 33 per cent were of asexual forms.

Such apparently low parasitemia and splenomegaly at present, however, are not a guarantee of safety from future malaria epidemic (11), because of the significant number of gametocyte carriers and of the environmental conditions favoring the propagation of the mosquito vector which may play havoc among the new susceptible settlers in the northern rural areas of the city.

Observation of anophelism.—In the Northern Rural District, our findings on the collection of Anopheles larvæe are consolidated in Table 3. There is noticeably significant preponderance of *A. minimus* var. *flavirostris* larvæ (80.56 per cent in Marikina river tributaries, and 62.05 per cent in Novaliches river and tributaries), over all other species because of the relatively more primitive state of the area. By contrast, in the upper tributaries of San Juan river just north of the Banlat road, the vector species was observed only to be 30.2 per cent,

TABLE 3.—*Showing the results of Anopheles larvæ checking in the Northern Rural District (October 1–11, 1948) and Southern Urban District, (Sept. 2 to October 12, 1948), Quezon City*

Anopheles	Northern Rural District									Southern District			Remarks
	Marikina River and tributaries			Novaliches River and tributaries			San Juan River and upper tributaries			From 25 tributaries of San Juan River			
	Larvæ in 1,360 dips	Density per dip	Rate	Larvæ n 1,250 dips	Dens i y per dip	Rate	Larvæ in 1,120 dips	Density per dip	Rate	Larvæ in 1,330 dips	Density per dip	Rate	
			Per cent			*Per cent*			*Per cent*			*Per cent*	
Minimus var. *flavirostris*	203	0.15	80.56	103	0.08	62.05	81	0.02	30.22	125	0.09	17.09	
Hyrcanus var. *nigerrimus*	22	0.02	8.73	23	0.028	13.86	35	0.03	13.05	52	0.04	7.11	
Lesteri	4	0.003	1.59	16	0.010	9.64	19	0.02	7.09	367	0.28	50.20	
Manalangi	13	0.009	5.16	2	0.002	1.20	26	0.02	9.70	8	0.06	1.09	
Annularis	5	0.004	1.98	2	0.002	1.20	6	0.005	2.24	30	0.02	4.10	
Kochi	5	0.004	1.98	1	0.001	0.60	0	0	0	0	0	0	
Filipinæ	0	0	0	6	0.004	3.61	1	0.001	0.37	12	0.09	1.64	
Philippinensis	0	0	0	8	0.006	4.82	4	0.003	1.49	59	0.04	8.07	
Barbirostris	0	0	0	5	0.004	3.01	0	0	0	2	0.002	0.27	
Vagus var. *limosus*	0	0	0	0	0	0	96	0.09	35.82	76	0.06	10.40	
Total	252	0.185	100.00	166	0.13	99.90	268	0.24	99.80	731	0.55	99.98	

TABLE 4.—*Anopheles adult catches from their daytime resting places in the Northern Rural District, (October 1–11, 1948) and the Southern Urban District, (August 25 to October 12, 1948), Quezon City*

Anopheles	Northern Rural District						Southern Urban District		Remarks
	Marikina River and tributaries		Novaliches River and tributaries		San Juan River and upper tributaries		San Juan River and Mariablo lower tributaries		
	Number		*Per cent*		Number		*Per cent*		
Minimus var. *flavirostris*	48	68.57	22	48.88	4	18.18	3	20.00	Marikina River includes 27 tributaries.
Filipinae	1	1.43	8	17.78	2	9.09	1	6.66	
Hyrcanus var. *nigerrimus*	6	8.57	2	4.44	8	36.36	0	0	
Manalangi	2	2.86	2	44.4	1	4.55	0	0	
Tesselatus	4	5.71	1	2.22	0	0	0	0	
Vagus var. *limosus*	1	1.43	4	8.88	0	0	10	66.66	Novaliches River includes 22 tributaries.
Philippinensis	4	5.71	4	8.88	4	18.18	0	0	
Annularis	2	2.86	0	0	1	4.55	0	0	
Karwari	2	2.86	0	0	0	0	0	0	
Lesteri	0	0	1	2.22	1	4.55	1	6.66	San Juan River includes 14 tributaries in rural district.[1]
Kochi	0	0	1	2.22	1	4.55	0	0	
Subpictus var. *indifinitus*	0	0	0	0	0	0	0	0	
Total	70	100.00	45	99.96	22	100.00	15	99.98	

[1] San Juan River tributaries in Urban district had in 4 spots only positive for Anopheles adults in a total of about 12 kilometers of streams

which was surpassed by *A. vagus* var. *limosus* (King), stagnant water breeder by more than five per cent. This might be attributed (*a*) to the hydrotechnical measures instituted in some streams north of the University of the Philippines site by the Malaria Control Section before the war, (*b*) to the agricultural development in the area south of the Capitol site and north of the Banlat road to Balara, (*c*) to the other biological changes in the streams due to the presence of sizeable flocks of livestock, and (*d*) to the fact that the water in the upper tributaries of San Juan river tends to stagnate, as it traverses a low-lying area,—of very much lower elevation than those of Marikina and Novaliches rivers.

Larval densities (see Table 3) of *A. minimus* var. *flavirostris* were 0.15 l.p.d.[a] in Marikina river tributaries, 0.08 l.p.d. in Novaliches river and tributaries, and 0.07 l.p.d. in the upper tributaries of San Juan river. These figures are significantly higher than those obtained for other species, except for *A. vagus* var. *limosus* in the last named stream. Other larvæ included in the collections were *A. hyrcanus* var. *nigerrimus* (Giles), *A. hyrcanus* var. *lesteri* (Baisas et Hu), *A. manalangi* (Mendoza), *A. annularis* (Van der Wulp), *A. kochi* (Doenitz), *A. filipinæ* (Manalang), *A. philippinensis* (Ludlow), and *A. barbirostris* (Van der Wulp).

Anopheles imagines caught in their daytime resting places (see Table 4) were *A. minimus* var. *flavirostris, A. filipinæ, A. hyrcanus* var. *nigerrimus, A. manalangi, A. tessellatus* Theo., *A. vagus* var. *limosus, A. philippinensis, A. annularis, A. karwari* (James), *A. hyrcanus* var. *lesteri,* and *A. kochi* (Doenitz). Like its larva, *A. minimus* var. *flavirostris* adults from its daytime resting places outranked markedly the other species in Marikina river tributaries (68.57 per cent) and in Novaliches river and tributaries (48.88 per cent). However, this is not the case in the upper tributaries of San Juan river north of Banlat road where *A. hyrcanus* var. *nigerrimus* predominates over other species probably because of the abundance of ricefields in the neighborhood and other factors already described about Anopheles larvæ. It might be noted that *A. karwari* adults were trapped, but its larvæ were not found because of the paucity of its preferential breeding habitats.

It appears on Table 5 that catches on the sixteen species of Anopheles from the animal-baited trap at Sitio San Bartolome in November to December 1948, are at variance, probably be-

[a] l.p.d.—larva per dip.

cause of the seasonal occurrence of their preferential breeding habitats within their flight range to the trap. The prevalence of Anopheles imagines caught ranked from the highest to the lowest, is as follows:

1. *A. vagus* var. *limosus*
2. *A. philippinensis*
3. *A. subpictus* var. *indefinitus* (Ludlow)
4. *A. annularis*
5. *A. filipinæ*
6. *A. minimus* var. *flavirostris*
7. *A. manalangi* and *A. tessellatus*
8. *A. litoralis*
9. *A. hyrcanus* var. *nigerrimus*
10. *A. barbirostris*
11. *A. karwari*
12. *A. hyrcanus* var. *lesteri* and *A. kochi*
13. *A. maculatus*
14. *A. ludlowi*

A. maculatus was insignificantly present in the area.

TABLE 5.—*The Anopheles adult trap catches in the Northern Rural District and Southern Urban District, Quezon City*

Anopheles	San Bartolome Northern District				Kamuning Southern District	
	252 trap-hours November 1948		252 trap-hours December 1948		160 trap-hours	
	Number	Density	Number	Density	Number	Density
Minimus var. *flavirostris*	222	0.88	95	0.38	2	0.01
Maculatus	2	0.007	0		0	0
Filipinæ	180	0.71	153	0.61	3	0.02
Vagus var. *limosus*	622	2.47	150	0.60	1,787	11.17
Subpictus var. *indifinitus*	399	1.58	221	.088	29	0.18
Ludlowi	1	0.004	0	0	0	0
Citoralis	13	0.05	85	0.34	0	0
Manalangi	103	0.41	22	0.09	2	0.01
Lesteri	7	0.03	6	0.02	252	1.58
Hyrcanus var. *nigerrimus*	259	1.03	72	0.30	363	2.27
Barbirostris	40	0.16	20	0.09	14	0.09
Karwari	16	0.06	3	0.01	0	0
Kochi	8	0.03	5	0.02	0	0
Tesselatus	19	0.08	116	0.46	14	0.09
Annularis	400	1.59	38	0.15	522	3.26
Philippinensis	5,878	20.9	96	0.38	101	0.63
Total	7,669	30.43	1,082	4.29	3.087	1.92

[1] Number of mosquitoes trapped divided by the number of trapping hours gives the density per hour.

THE SOUTHERN URBAN DISTRICT

Observations on the human host.—The following is a record on malaria morbidity and mortality during 1948 from the Office of the City Health Officer of Quezon City, located in this District:

Annual morbidity and mortality from malaria per 1,000 population

Month	Cases	Morbidity	Deaths	Mortality
1948				
January	5	0.090	1	0.018
February	2	0.046	0	0
March	1	0.018	0	0
April	4	0.072	0	0
May	9	0.162	0	0
June	7	0.126	0	0
July	6	0.108	0	0
August	7	0.126	0	0
September	12	0.216	0	0
October	2	0.036	0	0
November	8	0.144	2	0.036
December	2	0.036	0	0
Total	65	1.170	3	0.054

Parasite and spleen surveys among the three age-groups were made in ten places (grouped into 3 areas according to their natural features, and locations) in the district (Table 2). The following points may be deduced:

1. There was no significant difference in number between *P. vivax* and *P. falciparum*. They were too few to merit comparative consideration.

2. Out of ten places grouped into three representative areas only the Balara Filter Compound showed evidence of autochthonous recent malaria through observed infant infection with 8.33 per cent.

3. Parasite and spleen indices in children from 2 to 10 years of age were 2.22 per cent and 4.44 per cent, respectively. These data were, however, obtained in Balara Filter Compound only. In subjects above ten years of age, they ranged from 0.17 per cent to 1.1 per cent with an average of 0.16 per cent in 1,887 examinations for parasites, and from zero to 1.10 per cent spleen with an average of 0.11 per cent; but those positive cases encountered at the South market neighborhood, Diliman, were apparently imported from Nueva Ecija.

4. The Balara Filter Compound, which is the most elevated in the district, showed outstanding parasite and spleen rates with 1.8 per cent gametocyte rate, while the low-lying areas showed negative findings.

5. For all age groups, the parasite and spleen rates were reduced to 0.16 per cent and 0.11 per cent, respectively.

Observations on anophelism.—Findings on Anopheles larvæ are shown in Table 3. It will be noted that, in 1,330 well distributed dips in twenty-five tributaries of San Juan River, *A. minimus* var. *flavirostris* was second only to *A. hyrcanus* var. *lesteri*, and constituted 17.09 per cent and 50 per cent, respectively. These figures apparently show that about 83 per cent of the breeding habitats harbored harmless species, because of the permanent control works effected in streams during the prewar period. Other larvæ collected were identified as *A. vagus* var. *limosus*, *A. philippinensis*, *A. hyrcanus* var. *nigerrimus*, *A. annularis*, *A. filipinæ*, *A. manalangi*, and *A. barbirostris*, in the order of their abundance.

The Anopheles imagines from their daytime resting places and the animal-baited traps are presented in Tables 4 and 5, respectively. It will be noted that only two *A. minimus* var. *flavirostris* adults were trapped among 3,087 Anopheles adults during the period from August 25, 1945 to October 12, 1948 (observed favorable season for the dispersion of the species).

The species trapped are ranked as follows:

1. *A. vagus* var. *limosus*
2. *A. annularis*
3. *A. hyrcanus* var. *nigerrimus*
4. *A. hyrcanus* var. *lesteri*
5. *A. philippinensis*
6. *A. subpictus* var. *indefinitus*
7. *A. barbirostris* and *A. tessellatus*
8. *A. manalangi* and *A. minimus* var. *flavirostris*

In spite of the extensive search by a group of six trained men, captures of Anopheles imagines in their daytime resting places (Table 4) along the borders of the streams were few, owing to finished control measures. *A. minimus* var. *flavirostris*, *A. filipinæ*, *A. vagus* var. *limosus*, and *A. hyrcanus* var. *lesteri* were caught from only four spots in view of the extensive elimination of favorable harborages before the war.

MALARIA CONTROL WORKS IN THE SOUTHERN URBAN DISTRICT [1]

In the Southern Urban District, unlike that of the Northern Rural District, malaria control works financed from fiduciary

[1] Compiled from the records of the Section of Malaria Control.

funds from the University of the Philippines, and from the Administration of Quezon City were undertaken by the Malaria Control Section of the Department of Health in the U. P. Site and in other areas of the district from November 1938 to November 1941. The accomplishments and effective results as shown in the findings on anophelism in the locality were as follows:

Accomplishments in the field	Meters
Automatic siphon sluices (Pl. 1, fig. 1)	6
Canals in the main streams (Pl. 1, fig. 2)	2,240.00
Ordinary "ripraps" (Pl. 1, fig. 3)	1,298.00
Semi-culverts (Pl. 2, fig. 4, 5, 7)	1,977.55
Canals dugged in natural adobe stone (Pl. 2, fig. 6)	1,343.99
Total	6,859.94

In addition to the permanent hydrotechnical control measures, temporary measures such as spreading of one per cent Paris green with fine road dust, in the unimproved streams, and clearing and sloping stream banks to destroy Anopheline harborages, were also undertaken.

Gradual and steady decrease of *A. minimus* var. *flavirostris* larva in relation to the other species resulted as the important breeding habitats were destroyed by the application of hydrotechnical measures. The yearly reductions were as follows:

Year 1938—19,484 in 38,801 total larva collection, or about 50 per cent.
Year 1939—52,322 in 116,462 total larva collection, or about 45 per cent.
Year 1940—7,741 in 31,877 total larva collection, or about 24 per cent.
Year 1941—1,312 in 5,928 total larva collection, or about 20 per cent.

The annual larval densities were steadily reduced as follows:

1938	.90 l.p.d.	1940	0.07 l.p.d.
1939	0.40 l.p.d.	1941	0.02 l.p.d.

Other Anopheles species had very low annual larval densities, as shown below:

	1938 l.p.d.	1939 l.p.d.	1940 l.p.d.	1941 l.p.d.
A. manalangi	0	0	0.01	0.02
A. filipinae	0.01	0.01	0.002	nil
A. karwari	0	0	nil	0
A. ludlowi	0	0	0	0.002
A. vagus var. *limosus*	0.02	0.09	0.08	0.03
A. barbirostris	0.78	0.34	0.09	0.01
A. hyrcanus var. *nigerrimus*	0.02	0.003	0.001	0.01

A. subpictus var. *indefinitus*	0	0.001	0.01	0.01
A. kochi	nil	nil	nil	0
A. philippinensis	0.03	0.02	0.001	0.001
A. annularis	0.02	0.02	0.01	0.003
A. hycarnus var. *lesteri*	0.004	nil	nil	0
A. maculatus	0	0	nil	0

Available records of the human-baited, and carabao-baited traps for the months of June, July and October, 1941, in Barangca, Quezon City, show that, of 343 anopheles adults trapped in the former, no *A. minimus* var. *flavirostris* was found; while in the latter, out of 24,957 imagines caught only 15 of the vector species or 0.06 per cent were noted.

The results of the catches in the animal-baited trap in Diliman near Tanke Creek show that the average annual density of *A. minimus* var. *flavirostris* was 0.42 a.p.t.h.[a] in 1940, as compared with only 0.18 a.p.t.h. in 1941. Moreover, it was 0.66 per cent in 1940 in a total of 187,013 trapped imagines, as compared with 0.20 per cent in 1941 in a total of 509 caught adults. To show its relation with the other species, the following results are presented:

Anopheles	1940		1941	
	Annual average Adult density	Adult in per cent	Annual average Adult density	Adult in per cent
Minimus var.				
flavirostris	0.42	0.66	0.18	0.20
Naculatus	0.004	0.01	0	0
Manalangi	0.36	0.56	0.24	0.26
Filipinae	0.23	0.36	0.03	0.03
Litoralis	0.25	0.39	0.03	0.06
Ludlowi	1.15	1.81	0.52	0.56
Vagus var. *limosus*	14.24	22.31	16.36	17.54
Subpictus var.				
Indifinitus	2.83	4.43	1.14	1.21
Barbirostris	0.05	0.08	0.05	0.05
Hyrcanus var.				
Nigerrimus	4.04	6.34	11.18	11.99
Tesselatus	0.20	0.31	0.10	0.10
Philippinensis	20.66	32.36	22.99	24.66
Annularis	19.29	30.22	40.40	43.33
Karwari	0.05	0.07	0	0
Kochi	0.06	0.09	0.004	0

A full year of trapping 1941 in Barrio Obrero gave the following results with carabao as bait:

	Annual average density a.p.t.h.	*Adults in per cent*
A. minimus var. *flavirostris*	0.43	1.88
A. manalangi	0.31	1.33

[a] Adults per trapping hour

A. filipinæ	0.05	0.24
A. litoralis	0.01	0.06
A. ludlowi	0.25	1.09
A. vagus var. *limosus*	11.11	47.37
A. subpictus var. *indefinitus*	0.71	3.00
A. barbirostris	0.01	0.03
A. hyrcanus var. *nigerrimus*	5.07	21.58
A. tessellatus	0.06	0.25
A. philippinensis	2.05	8.75
A. annularis	3.38	14.41
A. karwari	nil	0.001
A. kochi	0.001	0.003

Thus, it might be noted that harmless species, particularly *A. vagus* var. *limosus, A. hyrcanus* var. *nigerrimus, A. annularis,* and *A. philippinensis* predominate over *A. minimus* var. *flavirostris.*

The effect of the mosquito control (anti-imaginal) measures appears most significant on *A. minimus* var. *flavirostris* density in their daytime resting places in relation with other species. The average annual density per man-hour search dropped from 0.03 a.p.m.h.s.[a] in 1938 to 0.01 a.p.m.h.s. in 1939, 0.003 a.p.m.h.s. in 1940 and 0.002 a.p.m.h.s. in 1941.

In comparison with the minimum *A. minimus* var. *flavirostris* density of 33.8 a.p.m.h.s. during the favorable dispersion months in the area near the South Portal, La Mesa, Novaliches, in 1932 (10), the foregoing findings are indeed negligible, considering that *A. minimus* var. *flavirostris* constituted 80 per cent in 1938; 51.54 per cent in 1939; 44.52 per cent in 1940; and only 8.96 per cent in 1941 of the total annual Anopheles harborage catches in Quezon City.

The human-baited trap in Diliman registered a very low *A. minimus* var. *flavirostris* density with 0.02 a.p.t.h. as its peak from January, 1940 to November, 1941. In barrio Obrero, Kamuning Street, from January to November, 1941, a peak of only 0.05 a.p.t.h. was obtained with the human-baited trap. It is, therefore, evident that, judged from the paucity of the vector-species, malaria was of minor importance in the Southern Urban District of Quezon City. Such small catches of *A. minimus* var. *flavirostris* may be attributed to the hydrotechnical measures introduced in the City.

[a] Adults per man-hour search

SUMMARY AND CONCLUSION

1. Malaria is presently endemic among the inhabitants of the communities surrounding the Capitol Site. The endemicity gradually decreases from the Northern limit of the city southward to the communities near the University of the Philippines site.

2. Malaria is absent in that part of the Southern Urban District close to Manila and San Juan, Rizal.

3. The density of the mosquito vector, *Anopheles minimus* var. *flavirostris,* decreases as the land development increases southward from the Northern to the Southern boundaries of the city.

4. The mosquito control measures (anti-larval and anti-imaginal) directed against the vector species have redounded to the control of malaria in the Southern Urban District. The effetcive and practical value of permanent control measures have been demonstrated.

5. The malaria picture in Quezon City is what is usually seen in other areas of the Philippines, in that the disease is present in primitive barrios and sitios, but insignificant or absent in developed cities and towns, in conformity with the natural habitats of the vector species.

6. *A. maculatus* appears in a very low density, while *A. mangyanus* is absent.

RECOMMENDATIONS

In the light of our findings on malaria in Quezon City, we offer the following recommendations:

1. A committee consisting of malariologists, entomologists, and sanitary engineers to draw plan and program of malaria control should be created.

2. The necessary funds should be provided to carry out the plan and program drawn.

3. In consonance with the city building, we recommend permanent malaria control works:—these will be the continuation of the permanent hydrotechnical measures presently existing in the Southern Urban District, and their extension in the Northern Rural District of the City. In the construction of such permanent structures, the Master Plan Layout of the City must be consulted. Such projects will improve the general sanitation and beautify the locality.

4. Temporary anti-malaria measures may be resorted to, if and when scientific observations warrant their applications. In

so doing unnecessary loss of time and wastage of money may be avoided.

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ILLUSTRATIONS

Plate 1

Fig. 1. Automatic siphon sluice, University of the Philippines Site (Southern Urban District), Quezon City.

2. Raprapped canal for river tributary. Balara Filter Site (Southern Urban District), Quezon City.

3. Ordinary "ripraps" after straightening a small stream. Diliman Site (Southern Urban District), Quezon City.

Plate 2

Fig. 4. Inverts with adobe "ripraps" and cement tiles (manufactured by the Unit) for shoulders. University of the Philippines Site (Southern Urban District), Quezon City.

5. Laying out the drainage system. University of the Philippines Site (Southern Urban District), Quezon City.

6. Canal dugged in natural adobe stone (stream bed) Balara Filter Site (Southern Urban District), Quezon City.

7. Inverts finished with cement tiles. University of the Philippines Site (Southern Urban District), Quezon City.

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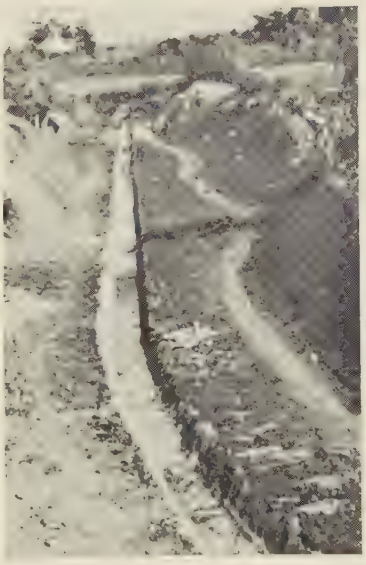

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PLATE 1.

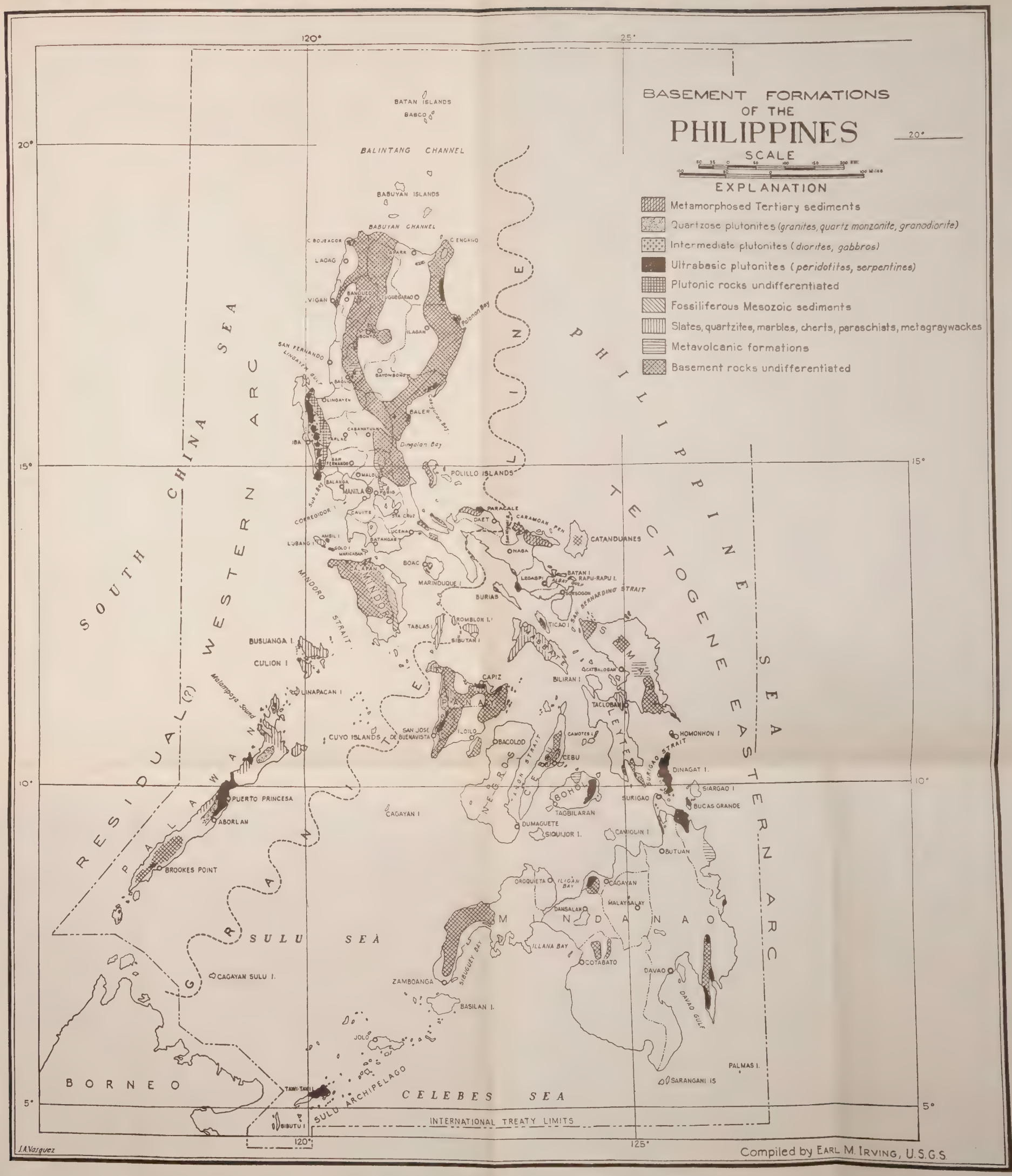

Plate 1. Map showing distribution of basement formations of the Philippines.

REVIEW OF PHILIPPINE BASEMENT GEOLOGY AND ITS PROBLEMS[1]

By Earl M. Irving
Of the Geologist, U. S. Geological Survey

ONE PLATE AND FIVE TEXT FIGURES

INTRODUCTION

Consideration of the basement formations arises in connection with the compilation of a new geologic map of the archipelago by the Philippine Bureau of Mines.

Basement formations crop out in the cores of many Tertiary mountain ranges and underlie approximately thirty per cent of the land area of the Philippine archipelago. The rocks consist of sedimentary and volcanic types that are metamorphosed to varying degrees and these are cut by a wide variety of plutonic and hypabissal igneous intrusives. The oldest paleontologically dated formations overlying the essentially crystalline basement are lower to middle Tertiary in age; the oldest dated formation within the basement rocks is Jurassic in age, accordingly, if the history of the Philippine archipelago has been comparable to that of adjoining archipelagos or to the continental mainland, possibly as much as 80 to 90 per cent of geologic time may be represented within them.

The present review, consisting of a compilation of published as well as unpublished data, attempts to describe briefly the distribution, constitution, and geologic relations of the basement formations as they are now known on each of the principal islands, or island groups, of the archipelago. Owing to great hiati of information, and generally inadequate descriptions rising out of many previous investigations, the compilation serves to emphasize how imperfectly the basement formations are known or understood. If the paper fails to convey an adequate concept of the rock units, perhaps its value lies in the stimulation of present and future students toward their more precise study in the future.

Certain problems and tentative generalizations are set forth at the conclusion of the paper.

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[1] Prepared for the Seventh Pacific Science Congress, Auckland, New Zealand, February 1949, and published by permission of the Director, U. S. Geological Survey.

ISLAND OF LUZON

The largest area of basement formations of the Philippines (Plate I) is exposed in the high cordillera of northern and eastern Luzon. The outcrop area is "Y" shaped. The western leg outcrops along the northwestern cordillera of the Ilocos and Mountain Provinces, and the eastern leg, including the stem of the "Y", follows along the Sierra Madre cordillera of the Pacific coast. Another large area crops out along the Zambales Range on the west-central side of the island. Several smaller areas are exposed along the peninsular ranges of the Pacific coast in southeastern Luzon and on adjacent islands to the east.

NORTHWESTERN CORDILLERA

Ilocos provinces.—One of the earliest investigations of the older formations of Luzon was undertaken by W. D. Smith (1907) in Ilocos Norte Province.

On the left bank of the north-flowing Baruyen River, Smith found float boulders and local outcrops of red, fine-grained, fissile chert which breaks into slabs 5 millimeters to several centimeters thick; to it he assigned the term "Baruyen chert".

Smith described thin-sections of the chert as follows:

> "This rock is seen to consist of a fine grained, amorphous groundmass of chalcedonic silica, copiously stained with oxide of iron, with almost innumerable round and oval areas which are more or less clear. In ordinary light the whole section resembles sections of some of the radiolaria cherts of the San Francisco peninsula, to judge from my memory of them and from descriptions."

Besides finding what he believed to be *Podocrystis* and *Bothryocampo* in the Ilocos cherts, at a much later date Smith (1924, p. 72) stated that he was able to identify specific forms of the genera *Cenosphaera* and *Dictyomitra* in specimens of lithologically similar cherts from Panay and Balabac Islands. These findings and their circumstantial association with serpentine, like the bedded cherts of the Franciscan formation of California with serpentine, lead him to assign the cherts a tentative Jurassic age.

During recent investigation of the area (Irving and Quema, 1948) large bodies of chert were found closely associated with serpentine and chloritic schist, but some are locally interleaved with serpentinous schist. The chert deposits are intensely folded along northwesterly trending axes, and are strongly fractured and brecciated. In many areas the fractures and the interstices of the breccias are filled or healed by chalcedony and fine-granular quartz. The formation is intruded, discordantly

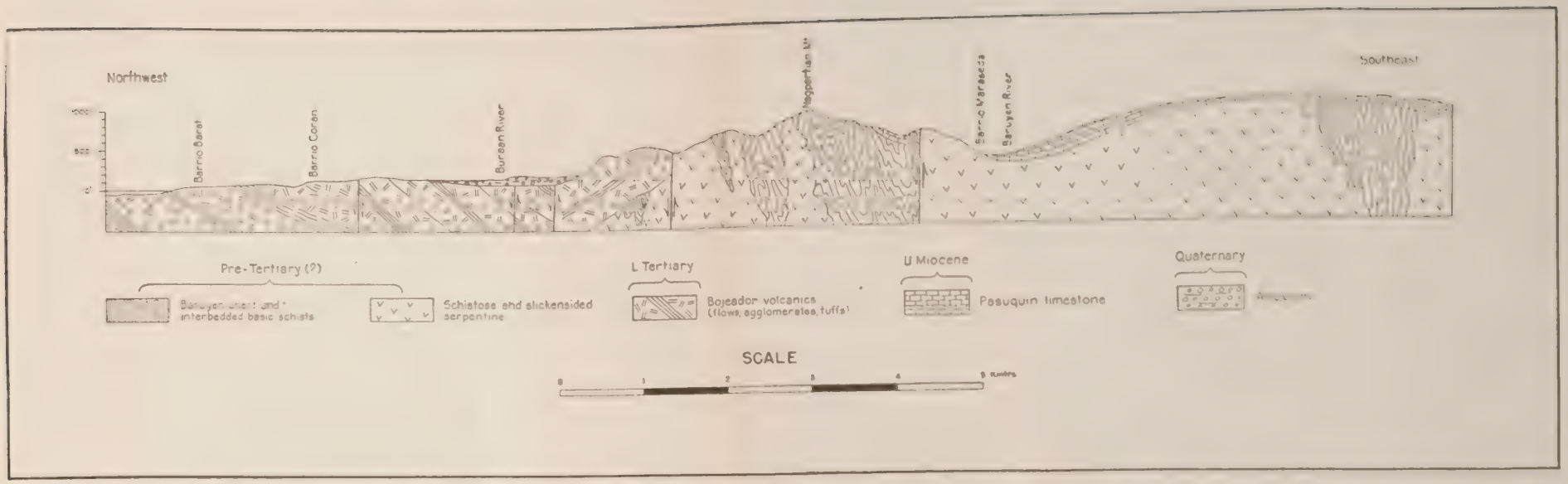

FIG. 1. Northwest-southeast geologic section through Baruyen River area, northwestern Ilocos Norte Province, Luzon (Irving and Quema, 1948).

in general, by peridotite and serpentinite which themselves possess schistosity and shearing parallel to regional basement structure. The basement upon which the cherts were deposited could not be distinguished.

Intruding the cherts and serpentines as dikes in the headwaters of the westward draining Caraon River, and as small lenticular bodies elsewhere, a white, eugranitic to gneissoid rock consisting of oligoclase, quartz, and muscovite was analyzed by L. A. Salinger of the Bureau of Science in 1906 with the following results: SiO_2, 72.76 per cent; Al_2O_3, 15.15 per cent; NaO, 5.06 per cent; and K_2O, 0.56 per cent. Another analysis by H. Moreno of the same bureau in 1941 gave SiO_2, 68.86 per cent; Al_2O_3, 18.16 per cent; Na_2O, 7.96 per cent; and K_2O, 2.42 per cent. Instead of granulite as termed by Smith, the high silica content and the preponderance of soda over potash suggest the rock is possibly *trondhjemite.*

It is now known that cherts of "Baruyen" type occur widely throughout the basement rocks of the Philippines, and may be associated either with other sediments, or more commonly with volcanics which are metamorphosed in varying degrees. While it is true that many contain skeletons of micro-organisms, probably radiolaria, few can be accurately identified in thin-section. Appreciating the general fractious nature of radiolaria for purposes of correlation, the Jurassic age of these cherts, it is believed, must be held with reservation, in view of the fact that lithologically similar cherts occur in many widespread localities, and often under quite different geological associations. The age of the chert and the orogeny involving them in the Ilocos area, and of the intrusion by plutonics, therefore, cannot be dated with certainty. The oldest fossiliferous Tertiary beds overlying these rocks are upper Miocene. A thick section of folded volcanic agglomerates and tuffs lies between the marine Tertiary beds and the basement. These volcanic rocks are not metamorphosed and are probably of lower to middle Tertiary age.

On the highway south of Vigan, Ilocos Sur, diorite crops out at Solvec Point but the strongly folded middle Tertiary sandstone and shale cover obscures the country rocks into which it was intruded.

James Cushing (personal communication) reported that an elliptical north-south trending stock of granitic composition, 20 by 30 kilometers across, intrudes basic volcanics in the Abra gold mining district a few miles east of Bangued, Abra Province.

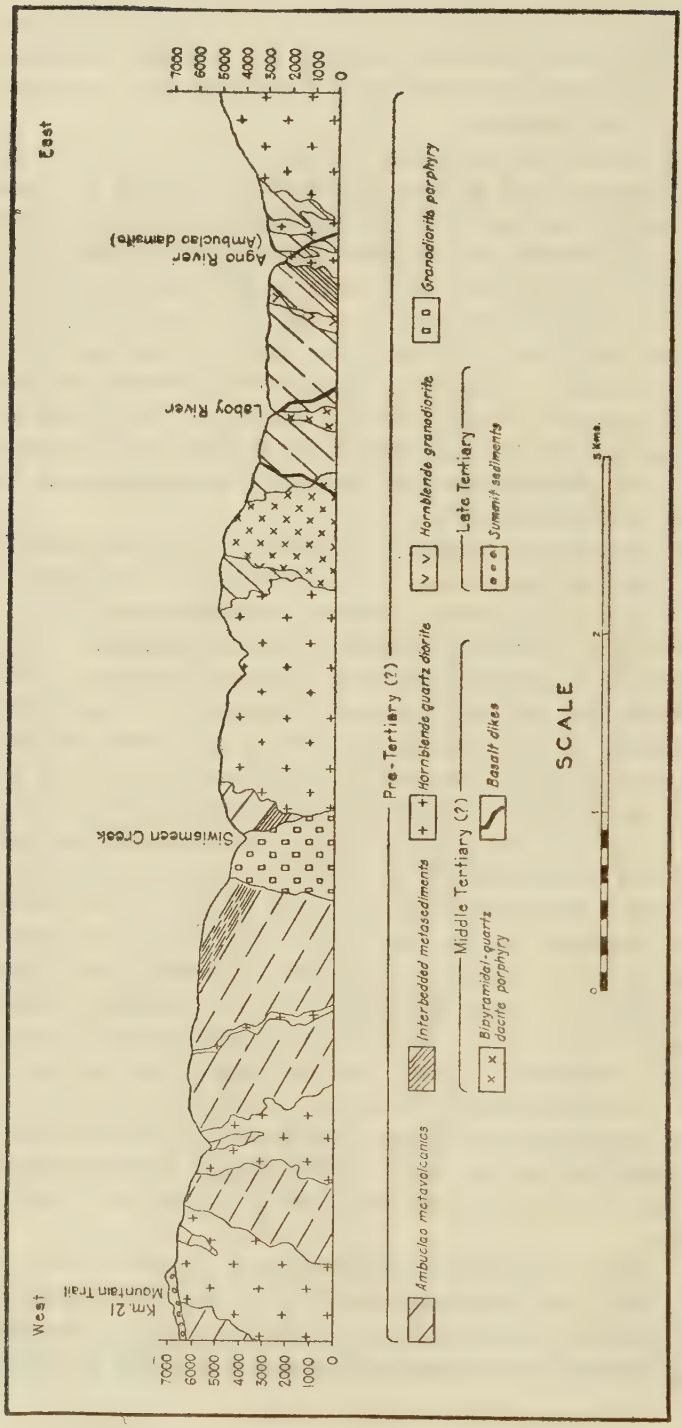

FIG. 2. East-west geologic section from kilometer 21, Mountain Trail, to Ambuclao damsite on the Agno River, Mountain Province, Luzon (Irving and Oca, 1950).

Mountain Province.—While undertaking a reconnaissance of the high cordillera of Mountain Province in 1914, Smith (1915, p. 192) found grayish to whitish biotite granite at two points, one a short distance east of Bontoc and the other in the Saltan Valley. He stated "it appears to be a long intrusive mass whose axis runs from northwest to southeast." Bordering the intrusive granite was found a hornblende quartz diorite which he considered to be the basal formation for that area. These plutonic rocks are more extensive than their present outcrop area and being concealed by overlying extrusive volcanics, the country rock into which they were intruded is not known.

At the Lepanto copper property near Mankayan, the Lepanto ore-body occurs in metamorphosed basic volcanics, probably metaandesite and metabasalt, which, due to recrystallization, have lost most of their primary igneous textures and structures. These rocks are intruded by a large mass of biotite hornblende granodiorite whose contact passes in a north-northwesterly direction through the property. In the vicinity, both rocks are overlain by volcanics, probably of Tertiary age.

During recent foundation investigations of the proposed Ambuclao hydroelectric power damsite near the headwaters of the Agno River, a traverse (Irving and Oca, 1949) was carried across a portion of the central part of the cordillera. The oldest recognizable formation in this area consists of a great thickness of metaandesite and metabasalt, locally containing interbedded chert, impure quartzite, and metagraywacke. The rocks are broadly folded along axes trending N. 15° to 25° E. This folded sequence is broken into three north-south trending belts by elongated intrusives of hornblende quartz diorite which is probably the principal agent of metamorphism of the invaded rocks. This intruded metamorphosed sequence in turn is cut discordantly by smaller bodies of biotite hornblende granodiorite and of biotite feldspar granodiorite porphyry. After deep erosion of the range resulting from this orogeny, large masses of bipyramidal-quartz dacite porphyry were emplaced under a shallow rock cover as evidenced by the fine-grained texture of its groundmass. All of the foregoing were then intruded by thin basalt and andesite dikes that followed various joint systems in the rocks. On the bases of direct geological evidence, of mineral descent in accordance with the reaction principle, and of igneous textures, the first three intrusives appear to belong to a single magmatic cycle probably of pre-

Tertiary age. The dacite porphyry and effusive dikes are supposedly related to late Tertiary volcanism.

Baguio Area.—This renowned mining district has been described by numerous writers. The most comprehensive of these studies was by Andrew Leith (1938). The oldest rocks crop out as local areas in Antamok Valley and at Twin Rivers, near Itogon. They are described as mildly folded metamorphosed rocks, consisting of thinly laminated layers of light-colored siliceous and feldsphatic material, alternating with dark-colored hornblende, biotite, and chlorite-rich layers. Individual lamina are thin but occasional layers reach one to two feet in thickness. Leith believes these rocks are the product of static thermal metamorphism of "originally finely laminated shaly sand, or sandy shale, the fineness of the laminae suggesting a silt deposited in a lake or shallow sea" and that "apparently the folding preceded the development of the metamorphic minerals, for they show no regional parallelism, nor axial plane parallelism, such as is normal in dynamic metamorphism." Metamorphism is attributed to the rise in temperature attendant with widespread invasion of diorite magmas into the sediments when they were in "an unconsolidated condition and not under much load".

From many years of painstaking work in the district, Paul Schafer (personal communication), chief geologist of the Benguet Consolidated Mining Company, has found several additional areas of metamorphosed sediments, which, because of their isolated positions in the field, cannot be readily correlated. The widespread Pugo series in the southern part of the district contains metamorphosed volcanics similar in appearance to those of the Ambuclao area. Other sediments such as in the Atok-Big Wedge and in the Antamok Gold Field mine areas may be metamorphosed equivalents of Leith's Antamok series (Miocene?), or, they may also be parts of the basement. These older rocks are evidently overlain by the widespread, coarse clastic, Zig Zag series, which contains some red beds, and are clearly overlain by the Mirador limestone of Pliocene age.

Wisser (1940) argued that granodiorite intrudes extensive volcanic-rich sediments of "Vigo" (lower Miocene) type. Unfortunately Wisser's forceful argument loses much of its strength through his failure to establish definitely the "Vigo" age of the intruded rocks. Schafer, on the basis of additional evidence, however, agrees in principle with Wisser and goes further to say that the area is intruded by several coarse-grained intru-

sives, forming an irruptive complex that in part may be of upper Tertiary age, possibly correlative with the Paracale granodiorite of the Paracale Mining district, Camarines Norte.

The basement country rocks and the youngest coarse-grained intrusives enclose the immensely productive veins of the district.

SIERRA MADRE CORDILLERA

Northern Sierra Madre.—In 1913 Eddingfield (Smith, 1924, p. 140) passed by boat around the northern end of the Sierra Madre cordillera and along the northeastern coast of Luzon.

Near the ports of Dimalansan and Bicobian, north of Palanan Bay, Eddingfield reported coarsely crystalline pyroxenite (peridotite?) which is locally schistose, and surmised that it may extend inland as far as Mounts Cresta and Moises. He then reported the rocks near Casiguran Sound, north of Baler Bay, to consist mainly of diorite, andesite, and pyroxenite (peridotite?) which probably extend inland for 12 to 20 kilometers. East of Baler an outcrop of coarsely crystalline pyroxenite similar to that at Palanan Bay was also found.

About 15 kilometers southwest of Baler on the Boñgabon-Baler road, Corby (1940) reports a coarse-grained plutonic rock (diorite?) that appears to intrude serpentine, metamorphosed tuff and volcanics, and agglomerate. Some of the latter are intensely deformed and metamorphosed. Except the serpentine, the formations appear to be similar to the Pugo series, its intrusives, and the superjacent Tertiary volcanic rocks of the Baguio district.

The Central Knot Area.—The area where the Northwestern Cordillera joins the Sierra Madre Cordillera in Nueva Vizcaya Province is frequently termed the "Central Knot". This area is underlain mainly by thick-bedded, tilted Tertiary sandstone, shale, and conglomerate. Abella y Casariego (Smith, 1924, p. 145) stated that these sediments are in contact with diorite, probably by extensive faulting.

Southern Sierra Madre.—The oldest recognized rocks (Irving, 1947) of the Montalban-Mount Balagbag area northeast of Manila consist of andesites and basalts which enclose interbedded horizons varying in the thickness from a few feet up to several hundred feet thick, of thin-bedded to thick-bedded, regularly stratified, dark-gray clastic sediments, including occasional, finely-laminated red and green chert horizons. This interbedded sequence is intensely folded along structural axes trending N.–S. to N. 20° E. and is widely intruded by eugra-

nitic diorite, with local gabbroic facies, and by large bodies of granodiorite exhibiting strong lineal and platy structures which are accordant with the longitudinal structure of the country rocks. Moderate regional thermal metamorphism has converted these volcanics to metaandesite and metabasalt, and the interbedded sediments to hornfels-like argillite, impure quartzite, metaconglomerate, and jasperoidal chert. At Loobac, north of Montalban dam, and at Bosoboso, north of Teresa, isolated outcrops of serpentinized peridotite are exposed in small erosion windows of younger volcanics and for this reason the relationship of the peridotite to other intrusive rocks is not known.

Following deep erosion, lower Miocene conglomerate, sandstone, and shale and the Binañgonan limestones were deposited unconformably on the basement. These sediments in turn were strongly folded, probably in the middle Miocene, along structural axes similar to those of the earlier orogeny. Upper Tertiary volcanism is expressed by intrusion of numerous andesitic dikes into the complex, and by deposition of a thick series of lavas and agglomerates that mantle and bury the southern end of the range opposite Manila.

Judging from pebbles and boulders in rivers draining westward from the range to the north, similar formations probably extend as far north as Cabanatuan and San José, Nueva Ecija Province.

Definite age of the crystalline formations has not been determined. The basement rocks are, however, pre-lower Miocene, and judging from the amount of erosion that preceded deposition of the unmetamorphosed Miocene sediments, they may be Mesozoic or older.

ZAMBALES RANGE

The Zambales Range is a rugged cordillera extending along the western side of the island and lying between the Central Valley depression and the China Sea to the west. The range is composed of two district groups of igneous rocks of greatly different ages: (1) a belt of Tertiary volcanics along the eastern side of the range consisting of extrusive rocks on the Bataan peninsula and a series of andesite porphyry plugs that extend northward from Bataan peninsula and terminate at about the latitude of Tarlac, and (2) an unresolved complex of much older basic intrusives that extend northward along the western side of the range from the Cinco Picos Peninsula west of Subic Bay to the Hundred Islands area east of Cape Bolinao. The eastern

and western bases of the range are bordered by folded middle and upper Tertiary sediments which in turn are overlapped by recently elevated Quaternary sediments.

Smith (1924, p. 122) reports that the Cinco Picos Range west of Subic Bay is composed of pyroxenite, a rock-type found in masses of limited size and commonly associated with gabbroic intrusives. Judging from the large size of the area that supports only a meager vegetation, it is probable that much of the area is underlain by peridotite and serpentine.

At the latitude of Masinloc, the range appears to be composed of coarse-grained orthopyroxene gabbro which, as observed in road cuts, is coarsely banded. The banding strikes north-south, approximately parallel to the trend of the range, and commonly dips from 30° to 60° to the east. Both gabbro and diorite surround large masses of serpentinized peridotite in the vicinity of the great Masinloc refractory chromite ore-bodies, and fine-grained gabbro and diorite dikes cut both ore and serpentine country rock. The serpentine bodies therefore may have been much larger at one time and, during the gabbro-diorite igneous cycle, were broken and separated into smaller masses, which even yet are one to several miles across. The relationship of the later gabbro and diorite to the aformentioned banded gabbro requires additional study.

At the latitude of Santa Cruz, fifty kilometers farther north, the western side of the range is composed largely of serpentinized peridotite extending to a short distance east of the Acoje metallurgical chromite mines. In this area the serpentine intrusive is more than 12 kilometers wide. The eastern part of the range is reportedly composed of gabbro and probably diorite. On the Acoje mine road near a limestone quarry at the base of the range, a reddish, iron-stained, intensely fractured, siliceous rock, which appears to be ferruginous chert, is exposed. This is the only known occurrence at present of pre-intrusive sediments in the Zambales Range.

In 1912, Fanning (1912) undertook a rapid reconnaissance of the northern end of the range where it descends to sea level. Peridotite was observed on Portuguese Point near Sual. Gabbro was found in abundance from Sual northwestward and also south of Barlo; it was classified microscopically as hypersthene gabbro or norite. Syenite appearing "to occupy a position between granite and diorite" was reported in the same areas. Granite also is reported outcropping over small areas near Pao Bay, and

on Balincaguin River, 5 kilometers south of Barlo. Fanning made no attempt to describe the geologic relations of these igneous formations to one another, or to the country rocks which they must have intruded.

The basement rocks of Zambales Range, therefore, are seen to be one known small area of metamorphosed, pre-intrusive, sedimentary rocks near Santa Cruz, but mainly of intermediate to ultra-basic igneous types. Small areas of acidic plutonites occur at the extreme northern end of the range. Only when detailed regional mapping is undertaken will it be known whether the igneous sequence represents one or more intrusive cycles. The largest refractory and metallurgical chromite deposits of the Philippines and several small copper prospects, probably related to the gabbro-diorite magmatic sequence, occur in this largest known area of peridotites in the Philippines. The oldest dated Tertiary sediments overlying these rocks are lower Miocene.

SOUTHERN LUZON

Tayabas Isthmus.—Two areas of basement rocks crop out in the Tayabas Isthmus area of southern Luzon, one along the northern coast from west of Atimonan to the Santa Lucia River, the other bordering the south coast between Pinacapulan Point and Pitogo and extending inland 5 to 6 kilometers.

The northern area is reported by Birch and Merchant (Corby, 1940) to consist of coarsely crystalline diorite, which is locally intensely fractured and filled with quartz veins. Patches of green (chlorite?) schist are present. Altered green basic lavas, some serpentine, and gray schists (phyllites?) of northwesterly strike are found along the coast northwest of Atimonan. Similar rocks are reported on the northern side of the long, narrow Alabat Island to the northeast. The relationship of the various types to one another is not stated.

The southern area, according to the same author, consists of coarsely crystalline diorite. Unlike the northern area, the basement diorite is little sheared, and gneissoid structures are absent. The overlying metamorphosed Quezon formation of Oligocene (?) age appears to be similar to beds described by Pratt on the Caramoan Peninsula.

The oldest unmetamorphosed Tertiary rocks in this area are the Tayabas limestone (lower Miocene) which crops out south of Summit and along the coast southeast of Atimonan. The formation rests locally on schist, gneiss, and on volcanics. A small inlier of limestone grit overlying volcanics along the

axis of the Pitogo anticline, and lithologically similar to the Tayabas limestone, yields the Eocene orbitoid, *Camarina*. This appears to be a still older unit which is buried beneath the widespread Miocene sediments.

Paracale District.—Immediately before the war, geologists of the Philippine Bureau of Mines under the direction of W. Benjamin Meek (1941), conducted a detailed geologic study of the Paracale gold-mining district.

The oldest known rocks in this district are serpentinized peridotites. The country rocks into which the peridotite must have intruded are not recognized. Approximately 8,000 feet of lower Miocene shales, arkosic and graywacke sandstones, conglomerates, and minor limestone beds, are interpreted by these geologists as deposited across the eroded surface of the peridotites. These rocks were intensely folded along northwesterly trending structural axes, and intruded by amphibole diorite probably in middle Miocene time, and by basalt and andesites extending, it is suggested, in the Pliocene. The Tertiary sediments were thermally metamorphosed by the diorite intrusives which also were the ore bringers for the iron deposits of Larap Peninsula, Calambayungan Island, and the Agusan Iron Mines east of Batobalani. During the Pliocene and possibly extending even into the Pleistocene, the gneissoid biotitic Paracale granodiorite, Meek believes, entered mainly as a domal intrusive into the peridotite rocks and crops out now as a west-northwesterly trending, oval-shaped stock. The rich gold veins of the district are contained mainly in fractures and fissures of this latest intrusive. Regional stresses and possibly intrusive pressure imposed a compact schistose structure upon the serpentine immediately along the contact and a gneissoid structure that boxes the compass within the granodiorite. Some sediments along the southern and western margins of the granodiorite intrusive are reported to be granitized.

These geologists state that although the basal peridotites may be very old, they can be identified as only older than the lower Miocene sediments deposited across them. Other investigators who have reported peridotite cutting even younger rocks in this area appear to have confused peridotite with basic volcanic rocks and other basic dike-intrusives.

It is significant to note the youthful age Meek attaches to the intrusives and to the metamorphism of the country rocks they invade.

With reference to the Paracale granodiorite, unless good evidence exists to the country, the present writer would be disposed to believe that its emplacement followed the intrusion of the iron-ore-forming diorite, as part and parcel of the same igneous cycle. The development of the gneissoid structure in the granodiorite seems to suggest that it too may have been emplaced during a late stage of the middle Miocene orogeny.

Southwestern Coast.—Basement rocks crop out along the coast between Panganiran and Pantao, opposite Burias Island, consisting Birch reports (Corby, 1940), of "basic rocks and metamorphics" intruded by later diorite. Between Cabarian and Malacbalac, the rocks are described as highly veined and fractured serpentine.

Caramoan Peninsula.—The rocks of this relatively inaccessible area were described by Pratt (1915). The mass of the peninsula, Pratt states, consists mainly of metamorphic rocks, including "talc and mica schist, schistose massive rocks, and marble". The schists are considered to be of sedimentary origin. The planes of schistosity are parallel to the bedding planes and though the beds are strongly crumpled and distorted, stratification is rarely obliterated. Stratification and schistosity strike west-northwest.

Pratt defined and measured the following partial section along a stream flowing into the Lagonoy river is the vicinity of Sabang:

Strata	Approximate thickness in meters
Green schists: imperfectly bedded, compact, hard rocks	200
Fine-grained marbles; homogeneous, grey to white	20
Thin fissile beds of talc-schist, schistose shale, and micaceous schists; green, yellow, and brown, with quartz lenses along bedding planes	500
White and blue marble	2
Fissile beds of schists like above, but gradually passing into schistose, massive, light green or blue clastic rocks	800
White marble	5
Massive schistose fragmental rocks; light green to blue	Undetermined

Under the sub-title "Correlation", Pratt states:

"The metamorphic sedimentaries exhibit a succession of beds identical in its main features with the Philippine column of Tertiary sedimentaries. The observed sections in the metamorphosed sedimentaries and in the unchanged sedimentaries further east are similar, although the lower part of the metamorphosed section is developed in greater

thickness than the corresponding division of the unchanged rocks. Moreover, in ascending the Caramoan river, one passes gradually from unchanged sedimentaries to metamorphosed sedimentaries: that is to say, there is an evident transition from one formation to the other with no definite line of contact."

Pratt reports peridotite along the south coast of the peninsula at the base of the sedimentary rocks. Near Guijalo and Parucban fresh diorite forms the basement whereas on adjacent islands gneissic diorite seems to predominate. Hornblende diorite also was found in the vicinity of Mapid and around Tambang Bay on the north coast. On the east coast of Tambang Bay, a continuous exposure of a rock believed to be peridotite was found.

It thus appears that the plutonic igneous complex forms the basement to the metamorphosed sediments. Dynamothermal metamorphism converted the sedimentary rocks of the central and western parts of the peninsula to schists, leaving the sedimentaries at the eastern end unmetamorphosed.

The discovery of Tertiary sediments, thus metamorphosed, on the Caramoan Peninsula and in the Paracale district, and possibly in the Baguio area, points the question whether other crystalline schists in the Philippines might be of Tertiary age, and introduces the cartographic problem whether Tertiary crystalline schists should or should not be considered as part of the basement.

Southeastern Albay Province.—The basement rocks of Cagraray and Batan Islands acording to Birch and Merchant (Corby, 1940) are serpentine, and appear to be brought up by slicing along strong northwesterly trending faults. Judging from the number and distribution of its outcrops, serpentine probably has considerable areal extent beneath the Tertiary cover. The oldest dated formation in this area is the Sula limestone, of Eocene age. The somewhat metamorphosed and older Libog volcanic series is believed by these authors to overlie the serpentine basement, but this relationship has not been clearly established.

Rapu Rapu Island (Irving and Cruz, 1949), east of Batan Island, is comprised of three distinct rocks group of greatly different ages. The eastern two-thirds is underlain by strongly foliated epidote-feldspar-chlorite schist which is intruded by a gneissoid hornblende metadiorite that also injected the schist locally to form banded injection gneiss. The foliation of the

schist strikes N. 45° to 60° W., and in the southern part of the island dips steeply southward, while along the north coast it dips gently northward. Some of the schists units are clearly of sedimentary origin, but their uniform basic composition indicates that many of them are probably derived from basic volcanics. This older group appears to be the product of an early orogeny, and in turn is intruded by an augite-enstatite peridotite which underlies the western third of the island. The peridotite in turn is intruded by small masses of eugranitic hornblende diorite. These latter intrusives probably represent a second magmatic cycle during which compressive stresses were inoperative. The basement rocks are overlain by small patches of Miocene limestone and sandy calcareous tuff which dip away from the topographic axis of the island as if they had arched over the island during its recent uplift.

LUBANG ISLAND GROUP

The Lubang island group comprises several small islands about 85 miles southwest of Manila; the principal islands are Lubang, Golo, Ambil, and Cobra.

The high interior of the larger Lubang Island, from geologic studies near Looc Bay and judging from boulders in streams descending from the northern slopes, is composed mainly of thin-bedded, crenulated, dark-gray, phyllitic schist that contains occasional thin horizons, 3 to 12 inches thick, of impure quartzite. These rocks are strongly folded along northeast to east-west axes in the Looc Bay area, and are intruded, on the peninsula east of Looc, by a cream to buff, coarsely crystalline, biotite granite which by weathering and by wave action forms excellent commercial quartz-sand deposits along the beaches. A zone of hybrid rocks, several hundred feet wide, is found along the intrusive contact south of Looc. Numerous narrow quartz veins occur on the country-rock side of this hybrid zone. Similar schist, hybrid rocks, vein-quartz, and granite, as well as granodiorite and diorite, are represented among the river gravels along the northern base of the range between Tilic and the town of Lubang.

From a trip along the coast by boat, Smith (1924, p. 259) reported serpentinite near the barrio of Viga on the eastern coast of Lubang which may be related to that of Ambil Island across the channel. The entire island of Ambil appears to be composed of this rock.

Smith reported that the north and south side of Golo Island is composed of schist similar to that of Looc Bay, but the central part of Golo is underlain by serpentinite. Granite is reported by the same author on the northern part of Maricaban Island.

The basement rocks are overlain by young coral reaf deposits on the northern and western plains of Lubang. No Tertiary sediments have been reported.

MINDORO ISLAND

The central part of Mindoro rises to elevations exceeding 8,000 feet, and is composed mainly of basement rocks. Although gold-quartz veins have attracted prospectors in the northern part, and gold placers occur along several mountain streams including the Tanibay and Binabay Rivers, the interior of the island is little known.

Smith (1924, p. 257) states that schists, similar to those of Lubang Island, crop out along the northern side of the island. He also reports that rock specimens secured by Dr. E. D. Merrill from the summit of Mt. Halcon, the highest peak of the island, were identified by himself as andesite.

Teves (1937), in describing the geology of the Puerto Galera area of northern Mindoro, found chloritic and calcitic schists, biotite-feldspar gneiss, and marble intruded by small serpentine masses along the coast, and by large bodies of flesh-colored biotite-hornblende granodiorite in the highlands back of the port. The basement rocks in the coastal area are overlain by Miocene and younger shales, sandstones, and by recent coralline reef limestone. Teves is probably correct in stating that Mount Halcon is composed mainly of basement rocks, although volcanic types, as stated by Smith, may be also present.

Dean Frasché is reported by Corby (1940) to have identified granite, granodiorite, diorite, gabbro, peridotite, serpentine, schists, cherts, and slates, among the rock types in the basement.

Probably the most striking feature of the geology of the island is the discovery by J. S. Hollister, geologist for the National Development Company, of the first and only known ammonites in the Philippines. The ammonites were first collected from beds exposed near Colasi Point south of Mansalay Bay, southeastern Mindoro. Other specimens were found in limestone concretions as float along rivers emptying into Mansalay Bay. Hollister (Corby, 1940) states that back of the coast from Mansalay, eastward dipping sediments, several

thousand feet thick and consisting of unfossiliferous hard calcareous mudstones, and calcareous or siliceous carbonaceous sandstones, may be of the same age. The sediments of this section seem to be somewhat finer grained, however, than those near Colasi Point where a coarse conglomerate is associated with the ammonite-bearing beds.

De Villa (1941) collected a suit of ammonites from the above localities and identified the following species: *Phylloceras* sp., *Perisphinctes taliabuticus* Boehm, *Perisphinctes tignoani* n. sp., *Perisphinctes mansalayi* n. sp., *Opella* (Newmayria) sp., *Hammatoceras Moluccanum* Cloos, *Macrocephalites* sp., *Perisphinctes Komodoi, Perisphinctes Sularcum* Boehm, *Perisphinctes tiziani* Oppel. These fossils, whose identifications probably require review, led de Villa to assign a middle to upper Jurassic age to the beds.

The Mesozoic beds have a northeasterly trend whereas the Tertiary beds have a more northwesterly trend; the Mesozoic rocks are said to be little more deformed than the Tertiary rocks. It is suggested by Corby that Mindoro, like Palawan, may be a part of ancient Sundaland.

Feliciano and Basco (1947) re-studied the Mansalay area and they reported that on Wasig Creek, approximately 10 kilometers north of the town of Mansalay, the Mansalay sediments are intruded by serpentine, gabbro, and diorite, probably in that order, which converted the black shales to hornfels, black slate, and silicified shale, and at one point may be responsible for the formation of auriferous quartz veinlets as fracture-fillings. If these observations are correct, at least two orogenic cycles are represented, one in the rocks of the pre-Jurassic basement, the other involving the Jurassic sediments. Possibly a third oroganic disturbance is represented in the deformation of the overlying Oligocene Bandao and the lower Miocene Bulalacao limestones.

ISLAND OF MARINDUQUE

Marinduque, a nearly circular island that lies northeast of Mindoro and midway toward the Bondoc Peninsula of southeastern Luzon, is traversed by a north-south mountain range which divides it into two nearly equal parts.

The island was first visited by the geologist, Maurice Goodman, in 1907, and his manuscript report is quoted extensively by Smith (1924, pp. 148–152).

Goodman states that the basement rocks of the island are composed of diorite, which in places grades into quartz diorite. In some places, he states, "notably in the south-western part of the island, are immense serpentine and chloritic outcrops which resulted from the alteration of the most basic igneous rocks. These rocks have in places become so squeezed and shattered as a result of metamorphic processes to cause them to take on a felsitic texture, and to develop a marked cleavage structure". Quartz veins, some containing gold, copper, lead, and zinc, fill fractures in the igneous rocks at several localities.

In the gorge of Maculapuit Creek, a tributary to Boac River, Municipality of Mogpog, hematite ore bodies of the Gold Star Mining Company, are reported by Frasche (1940, p. 26) to be of contact-metamorphic type, occurring along the contact between diorite and quartzite (metavolcanics, E.M.I.).

Corby (1940) reports that diorite and serpentine predominate among the basement rocks but other basic intrusives also are present. Although the relations are not always clear, diorite appears to intruce the more basic types. Stray inclusions of marble, possibly related to the marbles of Mindoro to the west and of Tablas and Romblon Islands to the south, are occasionally found in the serpentinite. Some of the Tertiary limestones are crystalline and deformation has imposed a slaty structure upon some shales and siltstones. Serpentine appears to pierce the Catala marble of middle Miocene age, possibly in diaper structure, while near Gasan, a reverse fault brings serpentine against the Boac formation of late Miocene age.

The basement rocks are overlain by steeply dipping Tertiary sediments and interbedded volcanics, the oldest of which is the Torrijos formation of upper Oligocene to lower Miocene age.

ROMBLON, TABLAS, AND SIBUYAN ISLANDS

Romblon, Tablas, and Sibuyan Islands and their islet cortege form a small group lying north of Panay and about midway between the islands of Mindoro and Masbate.

Adams (1909) published a brief note on the rocks around the port and town of Romblon on the northern coast of Romblon Island. A fine-grained and thoroughly crystalline marble near the town strikes N. 30° E. and dips about 30° to the west. It varies from pure white, to mottled and streaked varieties in gray, bluish, greenish, or brownish tones. The marble is overlain on the west and underlain to the east by yellowish to gray micaceous and siliceous schists which are transected by

occasional quartz veinlets. Adams regarded both rocks to be of metasedimentary origin. The marble provided the basis for a polished-stone industry before the war.

Hollister (Corby, 1940) reports that similar schists are extensively exposed in southeastern Tablas and appear to be intensely deformed sediments with regular bedding. Marble is widely distributed around the northern end of Romblon, Alad, and Tablas Islands and on Cobrador Island north of Romblon. Scattered patches of marble are found also along the eastern coast of Tablas. The extensive outcrops of marble on the northern ends of Romblon, Alad, and Tablas Islands, according to Hollister, appear to represent northerly plunging anticlinal structures in the metamorphics. The oldest unmetamorphosed formation overlying these rocks is the Bagolinao limestone of middle Miocene age.

The western side of Sibuyan Island rises with sheer slopes to a single summit, Mount Sibuyan, whose elevation exceeds 6,000 feet. Smith (1924, p. 200) regarded this mountain as a volcanic stock. The vegetation of the upper part, as seen from the air, is unusually sparse despite the heavy rainfall it receives. Because it lacks the configuration of a volcanic structure, and has sparse vegetation, it is possible that the region may be underlain by serpentinite, at least in part.

ISLAND OF MASBATE

In describing the geology of the well-known Aroroy gold mining district of northwestern Masbate Island, Ferguson (1911) distinguishes two groups of rocks in the basement: (1) the sedimentary Kaal formation, and (2) the Aroroy quartz diorite. The Kaal strata consist of fine-grained, red and dark purple slates and occasional interlaminated layers of siltstone and graywacke. The beds are considerably contorted and metamorphosed, strike northeasterly, and dip steeply to the northwest. The hornblende quartz diorite intrudes the Kaal formation and although cropping out over only a small area in the extreme northern part of the Aroroy district, it widens extensively eastward forming the principal rock underlying the area between Guinobatan River and Magdalena Bay. Individual outcrops yield specimens that are found under the microscope to include diorite, syenite, and gabbro. Due to heavy overburden these various types could not be resolved into separate intrusives, and, accordingly, were tentatively included with the Aroroy quartz diorite formation.

Ferguson states that "Little can be said as to the absolute age of the Kaal formation. No fossils have been found, but judging from its position, its extreme contortion and considerable metamorphism, it is my belief that it may be classed provisionally as pre-Tertiary, the earliest Miocene shales of the Port Barrera formation". Several words are evidently missing following the comma after "pre-Tertiary" but it is understood from the context that the Port Barrera formation (Miocene) is the oldest overlying formation.

As a result of mapping by Robert Reed, Corby (1940) reports that the basement complex of eastern Masbate has the same aspect as in western Masbate. "It varies from a massive, chocolate-brown, fine-grained rock, usually bedded and jointed, to a dark porphyritic rock; associated with it are plentiful tuffs and pyroclastics. Cherts are also present. These rocks are often fresh-looking and may be Tertiary in age".

BALABAC-PALAWAN-BUSUANGA ISLAND GROUP

The geology of this northeasterly trending island chain is probably the least known of the Philippines, yet because, like the Sulu Island group, it links the Philippines with the mainland of Borneo, its geologic and tectonic history may have considerable significance in the proper understanding of the origin and history of the archipelago. The basement geology of each island as it is known will be described beginning with the southernmost, and proceeding northward.

Balabac Island.—In 1913 R. A. Rowly visited Balabac island and collected various rock specimens. Among these Smith (1924, p. 249) found cherts in which he was allegedly able to identify radiolaria of Jurassic age.

During recent investigations (Irving, 1949), the east-central highland part of the island was observed to be composed of highly folded and twisted, dark red to chocolate colored, ferruginous shaly limestones which contain quite regular and persistent ferruginous chert layers, 2 to 6 inches thick, which are separated by as much as 1 to 6 feet of limestone. The shaly limestone evidently became contorted by the mechanism of plastic flowage. The interleaved cherts layers, on the other hand, failed so completely by fracturing that it is difficult often to obtain hand specimens larger than small angular fragments. The fractured cherts are usually partially healed by later calcite veinlets and fillings, and occasionally by pyrolusite veinlets.

Along the eastern coast of the island the shaly limestone and fractured chert sequence is associated with strongly fractured, and somewhat metamorphosed (chloritized) volcanics of basaltic composition. Elsewhere the sediments and the volcanics are intruded by small bodies of serpentinized enstatite peridotite and by coarse-grained gabbro, specimens of which possess a remarkably fresh aspect. Around the southern, western, and northern sides of the island the basement rocks are overlain by lower Miocene siliceous sandstones and pebble conglomerates, with interbedded dark gray organic shales. This sedimentary sequence has been thrown into steeply dipping northeasterly-trending folds. Younger faults appear to have been important in delineating the distribution of formations as well as determining the present topography of the island.

The contrasting composition of the shaly limestones and interbedded siliceous cherts, both of which are quite ferrugineous and somewhat manganiferous, seems to require special explanation. Because these sediments are in addition associated with volcanics, it has been suggested that the sediments are of deep sea type, in which submarine volcanic springs may have contributed silica to the formation of the cherts. Under the microscope, the cryptocrystalline chert is observed to contain occasional small, sharply defined, round areas of micro-crystalline quartz which may represent recrystallized tests of radiolaria, although this could not be established. No unaltered or partially altered radiolaria could be found. At any rate, the suite resembles certain facies of the Danau formation, described as Jurassic (Molengraaf, 1902), Triassic (Umbgrove, 1938), or Carboniferous (Zeijlmann van Emmichoven, 1939), and which reportedly occurs on Banggai Island, Northeast Borneo, 30 miles to the south.

Palawan Island.—At San Antonio Bay on the east coast, southernmost Palawan, McCaskey (Smith, 1924, p. 251) reported quartz and red jasper (chert?) among the pebbles along the beach, and in the hills to the southwest, "beds of decomposed red slate and . . . . . rhyolite, or quartz trachyte".

During a recent brief visit at the port of Brookes Point by the present writer, the pebbles at the mouth of a large river that descends from the central cordillera and passes across the broad eastern coastal plain, were seen to comprise such various types as red ferruginous chert; gray, micaceous, thin-bedded

and somewhat schistose quartzite; silicified phyllite containing interleaved quartz veins along the schistosity; light-and dark-green serpentinite, coarse-grained granodiorite (ballast?) very similar to Hongkong granite; and a variety of volcanic types some of which are metamorphosed. With field binoculars (x10) the central cordillera is observed to consist of rugged angular topographic forms alternating with local areas of smooth profile and less vegetation, which, together with the pebble information, suggests the presence of a metamorphic terrain intruded by peridotite or serpentinite.

On the trail from Separation Point across to Alphonso XIII on the west coast, south-central Palawan, McCaskey (Op. cit.) reported that quartz and jasper are again found in the streams. Across the bay from Puerto Princesa, on the flanks of Mt. Pulgar, he reported a coarse-grained biotite hornblende diorite containing variable amounts of free quartz. In northern Palawan, on the trail between Malampaya Sound and Taytay, and around Taytay itself, he found "siliceous rocks and quartzites." At Malampaya Sound, McCaskey confirmed the statement made by Commander W. T. Bate of the British Navy in 1851, that Mt. Kapoas is composed of granite. From sands along the beach he deduced that the rock was probably a biotite granite.

In 1913, Rowley spent several weeks mainly in the vicinity of Taytay, northeastern Palawan, and submitted a collection of rocks which according to Smith include: diorite, chlorite schists, graphitic schist, talcose schist, slate, serpentine, quartzite, chert, and younger unmetamorphosed sediments.

E. M. de Villa (1941) spent two months on Palawan and is the first to present a reconnaissance map of the island. At the small village of Gulang Gulang, near Mt. Kapoas on the south end of the already mentioned Malampaya Sound, de Villa found a dark, iron-gray, dense rock that separates into thin parallel layers like a roofing slate to which he assigns the formation name, Gulang Gulang slates. The comparatively undisturbed and homogeneous slates, with beds varying from 20 to 30 feet in thickness, strike N. 30° to 70° W., and dip uniformly 40° to 60° north. The formation is said by de Villa "to lie upon some schistose rocks, chlorite-, graphite-, and talc-schist, the junction appears to be conformable" (?). De Villa states that the formation is metamorphosed by the Kapoas granite which intrudes it. With no fossils, and upon the basis of lithologic similarity to the "old slates" of Borneo, and to

slates associated with the ammonite-bearing shales of Mindoro, he assigns, questionably, a lower Jurassic age to the formation. These rocks in turn are overlain by shattered quartzites.

The biotitic Kapoas granite, de Villa states, crops out in addition east of Bacuit, west of Aborlan in the south-central part of Palawan, and on the island of Linapacan northeast of Palawan. The rock is commonly pale gray, fine-grained, and contains abundant quartz. Peridotite also was reported to crop out extensively west of Puerto Princesa, and gabbro associated with peridotite near Baheti, Bentoan Bay. The age of the peridotite and gabbro with respect to the granite is not given, nor the age of the orogeny, or orogenies, implied by their emplacement.

Eocene limestone at Maytiguid Island, and highly folded lower Miocene limestone north of Puerto Princesa, overly the foregoing basement formations.

Linapacan Island.—The Linapacan metamorphic series, as termed by de Villa, crops out on northern Palawan, on Linapacan, and on Culion and Busuanga Islands to the north. De Villa describes the series as it occurs on Linapacan Island, to consist of: (1) an underlying agglomerate containing large boulders of pure white quartz and manganese and iron-stained blocks of Kapoas-type granite near San Miguel, Linapacan; (2) an overlying unit, unconformable, of 20 meters of apparently rhythmically stratified, laminated quartzite, whose laminations vary in thickness from a few millimeters to 2 or 3 centimeters, and which sometimes are separated by thin clay partings; and (3) an overlying unit of coarsely stratified massive, compact, yellow quartzite, 30 to 40 meters thick. On Linapacan Island these sediments are said to be relatively flat-lying, but on Busuanga Island they have high dips. The sequence is regarded by de Villa to be of upper Eocene age on the basis of Himalayan-Malayan peninsula geology (!). No fossils are mentioned. The above-mentioned rocks are overlain locally by middle Miocene limestones and younger sediments.

Culion Island.—Smith (1924, p. 254) quotes from a manuscript by McCaskey that in sea-cliffs below the town of Culion, Culion Island, he observed "a continuous exposure of highly metamorphosed, twisted and contorted, and occasionally faulted, quartzites." The quartzite is light yellow, varying to pink, and, at one outcrop where a thickness of about 18 meters was exposed, 160 thin but distinct laminae were counted. From a trip around the island by boat, with brief observations at

several points, the island, according to McCaskey, appears to be composed mainly of thin to thick-bedded quartzites containing interlaminated and interbedded argillites. Thus far, attempts to determine the age of these rocks have been unsuccessful.

Busuanga Island.—On the southern coast of Busuanga, McCaskey found outcrops of highly siliceous rock that appeared identical with the quartzites of Culion. From mining operations it is known that Busuanga is composed entirely of highly folded, thin-bedded quartzite and chert of unknown age.

PANAY ISLAND

Much that is known of the basal rocks of Panay results from the work of the Spanish geologist, Enrique Abella y Casariego (1890), between 1886 and 1890.

The island of Panay is roughly triangular in form, bounded on the west by a youthful cordillera, trending north-south, and composed mainly of crystalline rocks, and on the east by a lower, northeasterly trending mountainous cluster composed of similar rocks. A belt of basement rocks connects the two cordillera across the northern part of the island. Between these unequal diverging cordillera, the basement formations are overlain by an almost complete section of middle and upper Tertiary sediments said by Pratt to be 9,000 meters thick. The Tertiary sediments are flexed into a broad syncline which plunges gently from a low northern divide southeastward toward and beneath the Iloilo plain.

The basement rocks of the western cordillera are composed of thin-bedded siliceous cherts which are interbedded with metamorphosed volcanics, some of which retain pillow structures. These rocks are cut by various igneous intrusives. Abella y Casariego listed the following igneous types from the cordillera: picrite (olivine, augite, bronze hypersthene), serpentine, gabbro diorite, quartz diorite, tonalite, andesite, basalt, diabase, and trachyte. Picrite was reported on Rio Tigpuluan near Amayon, Sibalom, and at Anini, Antique Province, and on Mount Sinalman, Miagao, Iloilo Province.

Serpentine also is found on Punta Mabgaran, Tangalan, Capiz Province; on the island of Pan de Azucar, and at Concepción, Iloilo Province. Diorite and quartz diorite occur in a number of localities in Capiz and Antique Provinces, and gabbro at several points in Iloilo Province.

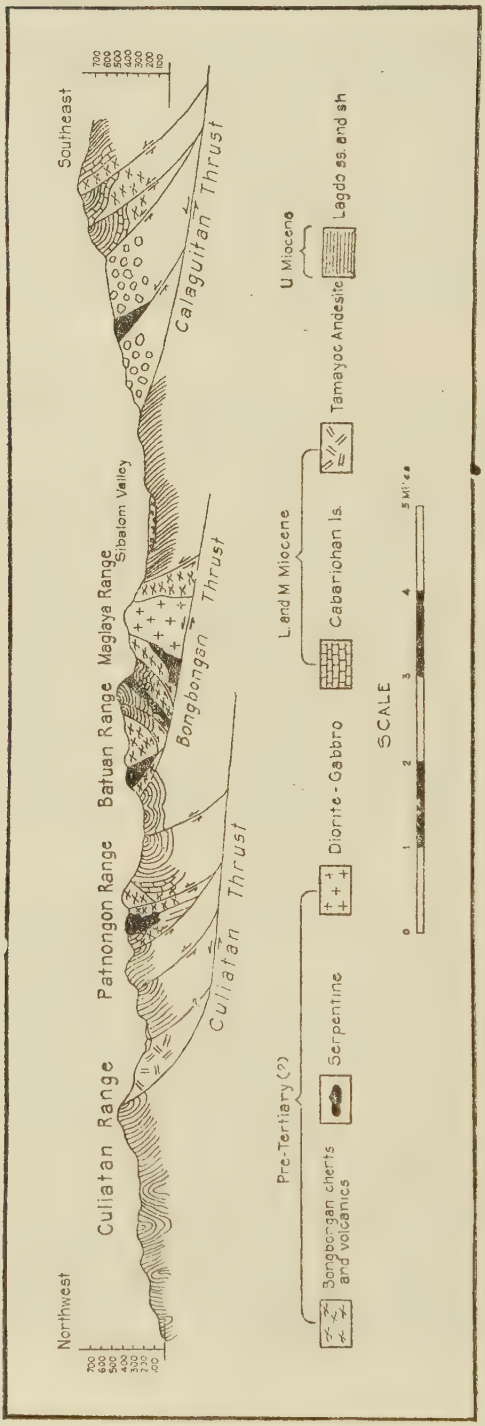

FIG. 3. Northwest-Southeast geologic section from near Patnongan, through Bongbongan, to and beyond San Remigio, Antique Province, Panay (by Luis Santos Yñigo, 1949).

Near the headwaters of the Ulian River in south-central Panay, at an elevation of 1,000 feet, Smith (1915) found indurated sediments resembling slate which are intercalated by diorite sills 3 to 5 meters thick. At another locality in the same area is found a "blue-black, very dense, exceedingly fine-grained rock" with conchoidal fracture that possesses a fine sedimentary banding. Because its partings were not typical of a slaty cleavage, Smith called it for want of better term, pseudoslate. He found also a reddish, fissile, siliceous, jasper-like rock, similar to that of Ilocos Norte on Luzon, in which he states he was able to identify the radiolaria: *Stylosphera* sp., *Dictyomitra affina, Cenosphaera minuta,* and *C. disseminata.* These fossils lead him to assign a Jurassic age to the sedimentary rocks.

On the Buruanga Peninsula of northwestern Panay, Luis Santos-Yñigo reports (personal communication) mica-quartz schist which contains interbedded coarse-grained marbles. Both strike N. 30° W., and are intruded by a flesh-colored biotite diorite.

During recent examination of the copper-pyrite deposits of southern Antique Province, Santos-Yñigo (1949) discerned extensive thrust-faulting and for the first time conclusively established its existence in the Philippines. Thrusting has caused intimate imbrication of basement formations with Tertiary sediments (See Fig. 3). The oldest formation recognized in the Bongbongan and San Remigio cooper mines area, located northeast of San José, consists of thermally metamorphosed basaltic lavas with interbedded manganiferous cherts, and occasionally, green clastic sediments. Pillow lavas are abundantly represented, suggesting that many of the erruptions were submarine. The metamorphics are intensely folded along NE–SW axes, and are intruded by strongly serpentinized peridotite, by local masses of gabbro containing gabbroic pegmatites, and by possibly two generations of diorite. In the late Miocene, strong compression from the southeast caused low angle thrusts to develope, and resulting that successive plates of basement became sandwiched between belts of strongly deformed lower Miocene limestones and andesites, and upper Miocene sandstones and shales. Late Miocene deformation appears to have followed the same trend lines of the basement rocks, resulting that the regional geology now has strong northeasterly lineation. It is presumed that the basement of this area is of pre-Tertiary

age. Radiolaria in the cherts must await competent identification.

NEGROS ISLAND

Santos-Yñigo and Oca (1946) reported about 3,000 feet of highly indurated, steeply dipping and tightly folded shale, sandstone, and quartzite with local cherty and manganiferous horizons, in the area of Kabankalan, south-central Negros Occidental Province. The principal axes of folding trend northeast to southwest and this formation is unconformably overlain by Miocene coal-bearing formations. The authors suggest that on the basis of lithologic similarity these highly indurated sediments may be equivalent to the Cretaceous (?) Pandan formation of Cebu. As lithology alone is a weak field criterion for correlation of formations over great distances this possible correlation requires additional field data.

The copper deposits of Sipalay in southwestern Negros are reported by Santos-Yñigo to occur in a considerably altered quartz diorite whose age has yet not been established.

CEBU ISLAND

Cebu is a mountainous shoe-string island, trending north-northeast, in the geographic center of the Philippine archipelago. Basement rocks crop out in the north-central part forming the back-bone or core, as it were, of the island. A thick section of Miocene sediments directly overlying the basement formations is folded along northeasterly-trending axes and crops out extensively around the basement core. Southward they extend almost to the southern end of the island. Pliocene sediments unconformably overlie the Miocene sediments; these are arched into a broad anticlinal structure that determines the outline and present trend of the island. The superposition of the north-northeasterly elongated dormal structure of the Pliocene sediments upon the northeasterly trending folds of the Miocene sediments, complicated further by faulting (probably related to uplift), results that the intervening Miocene sediments now form an anticlinorium of complex structure between the basement formations and the overlying Pliocene sediments.

During the geological investigation of this island for petroleum possibilities, J. S. Hollister and E. Taylor (Corby, 1940) reported the occurrence of a highly contorted and steeply dipping sequence of crystallized and veined limestone, indurated

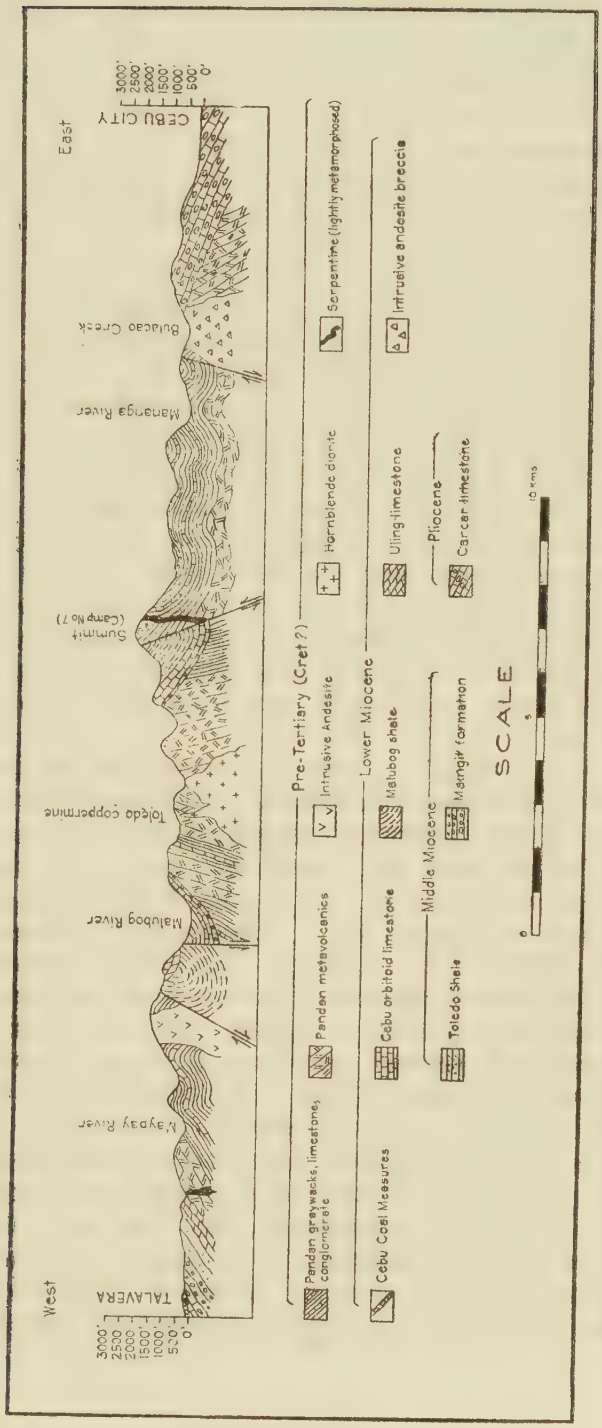

FIG. 4. East-west geologic section through Cebu Island at the latitude of the Tabunoc-Toledo road (by Luis Santos Yñigo, 1950).

shale, and conglomerate along the road from Naga to Uling, to which they assigned the formation name, Pandan. Similar rocks containing interbedded volcanics are exposed along the cross-island road between Tabunoc and Toledo. In a road-cut near kilometer post 24, the orbitoid *Orbitolina* was discovered in a prominent limestone outcrop. Although the single fossil was imperfectly preserved, this indicates that these rocks may be Cretaceous in age.

Recent geological mapping by Santos–Yñigo shows that similar rocks have broad aerial extent throughout the basement area. In places volcanics, varying from andesites to basalts, predominate; elsewhere sediments predominate. No structural breaks have been noted, accordingly the volcanics and sediments appear to be an interbedded sequence of probably considerable thickness. Some of the lavas possess well-defined pillow structures, suggesting that they represent submarine eruptions in part. The sediments and the volcanics show varying degrees of thermal metamorphism and propylitization; near intrusive contacts biotite hornfels, calcsilicate rocks, and epidote-rich recrystallized volcanics are common. Despite metamorphism, some of the limestones contain fossil remains and it is hoped that more data may be obtained regarding the precise age of the formation.

The Pandan formation is cut by several igneous intrusive types. The largest known body of serpentinized peridotite cuts volcanics of the Pandan near the summit of the Tabunoc–Toledo road, at kilometer post 26. Elsewhere serpentine seems to be confined to major faults, occurring as strongly slickensided blocks within larger fault zones. Occasionally coarse-grained hornblende schist, quartz albitite, and albitite impregnated hornblende schist are associated with such serpentine blocks; these may represent still older country rocks carried up along the fault zone. In several instances, these rocks have been transported such distances along faults that they lie between walls composed of Tertiary sediments.

In the vicinity of the Toledo copper mine, metamorphics of the Pandan type are cut by andesite porphyry bodies and these in turn by a slightly porphyritic diorite. The latter intrusive appears to have been the source of the copper, for the ore-body occurs within the older andesite porphyry. Near Malubog, metamorphics of the Pandan type are intruded by larger diorite masses.

The basement area of Cebu seems to present one of the best opportunities for downward penetration, geologically speaking, into the older geologic epochs of the archipelago, and warrants accordingly detailed and careful study.

BOHOL ISLAND

Basement rocks crop out in the northern part of the island. Southeast, south, and southwest of the town of Ubay, broad areas consist of serpentinized peridotite.

Corby (1940) reports that the basement complex consists of "an heterogeneous mass of volcanic flows, agglomerates, serpentines, intrusives, etc.". An intrusive plug of Tertiary age near Ilihan is said to be indistinguishable from the volcanics of the older rocks. South of Tubigon, in western Bohol, an intensely deformed sequence of volcanic rocks and sediments was found; it contains an Eocene fauna. The lower Miocene Wahig limestone cropping out in the gorge of the Wahig River overlies steeply dipping volcanic flows and agglomerate.

Thus, whereas some of the volcanics mentioned by Corby are undoubted Tertiary, others may be pre-Eocene. The age of the serpentine south of Ubay with respect to the older volcanics is not known.

LEYTE ISLAND

Basement rocks were first reported from Leyte by the German geologist, Fedor Jagor (Adams, 1909, p. 339) in 1860, when he observed grayish-green, chloritic schists near Tanauan, eastern Leyte. Adams visited the locality in 1909, and described a much squeezed and slickensided serpentine from a quarry one mile east of Tanauan.

From a private report by Ashburner, dated 1883, Becker concluded that basement rocks probably crop out on Panaon Island south of Leyte. Ashburner reported that gold prospects occur in a greenstone porphyry, which, according to Adams, might be a "diorite or a diabase". Adams discovered diorite and peridotite on the northern end of Panaon Island, near Liloan, and near Malitbog across the channel on the southernmost Leyte mainland.

Adams also reported a belt of sedimentary rocks north of Tacloban, which have been "metamorphosed into schists and altered shales by intrusive igneous rocks". Corby states that isolated hills along the eastern margin of the island as far south as Abuyog are composed of igneous rocks which are pre-Oli-

gocene in age and form the tectonic core of the island. The overlying Tertiary sequence has general westward tilt away form this structural high.

Corby also reports that the central cordillera of western Leyte is composed mainly of Pliocene to recent volcanic rocks, but that they may be in part older basement rocks. Mt. Magsanga in northwest Leyte is said to be composed mainly of peridotites and basalt. These older rocks are stratigraphically overlain by the strongly folded lower part of the Taog formation, of upper Oligocene or lower Miocene age, which may have been brought up along the axis of an anticlinorium.

SAMAR ISLAND

Information regarding the island of Samar is sketchy. Much of the available published data originated from a reconnaissance trip across the island by H. G. Schenck and G. B. Moody in 1920, of which Schenck (1922) published a brief summary. Corby, et al, conducted brief studies on the southern and western coasts, and on the Daram Islands to the west.

Central and southeastern Samar is underlain by a great variety of rocks. During his cross-island traverse, Schenck found red to brown fragments of jasper and chert in the headwaters of the Ulot river, near Loquilocan, which led him to suspect that these rocks might be found in place, probably in the area near Lawaan, north of Loquilocan. Two kilometers downstream from Loquilocan, he found outcrops of a hard, fine-grained, compact, blue-gray rock, which in the field appeared to be quartzite, but microscopic study proved it to be a feldspar porphyry. Farther to the west, near Bagakay, the rocks, composed mainly of fine-grained, fractured volcanics, were found in considerable structural complexity.

Dean Frasche (1940, pp. 25–26) reported the following rock types associated with the iron deposits of Pambuhan Sur, southeastern Samar; andesite, basalt, gabbro, serpentine, garnet schist, quartz monzonite, diorite, and gneiss. In the immediate vicinity of the Samar Iron Mining Company, the outcrops consist of serpentinized basic rocks which are overlain by a "series of limestones, marbles, and metamorphosed clastics which dip to the west and southwest at varying angles." The iron deposits are said to occur at the base of the sedimentary series near the contact with the underlying igneous complex.

Corby believes that the volcanic rocks of central Samar form the basement core of the island. The higher grade metamorphic rocks noted by Frasche may be the older of two groups.

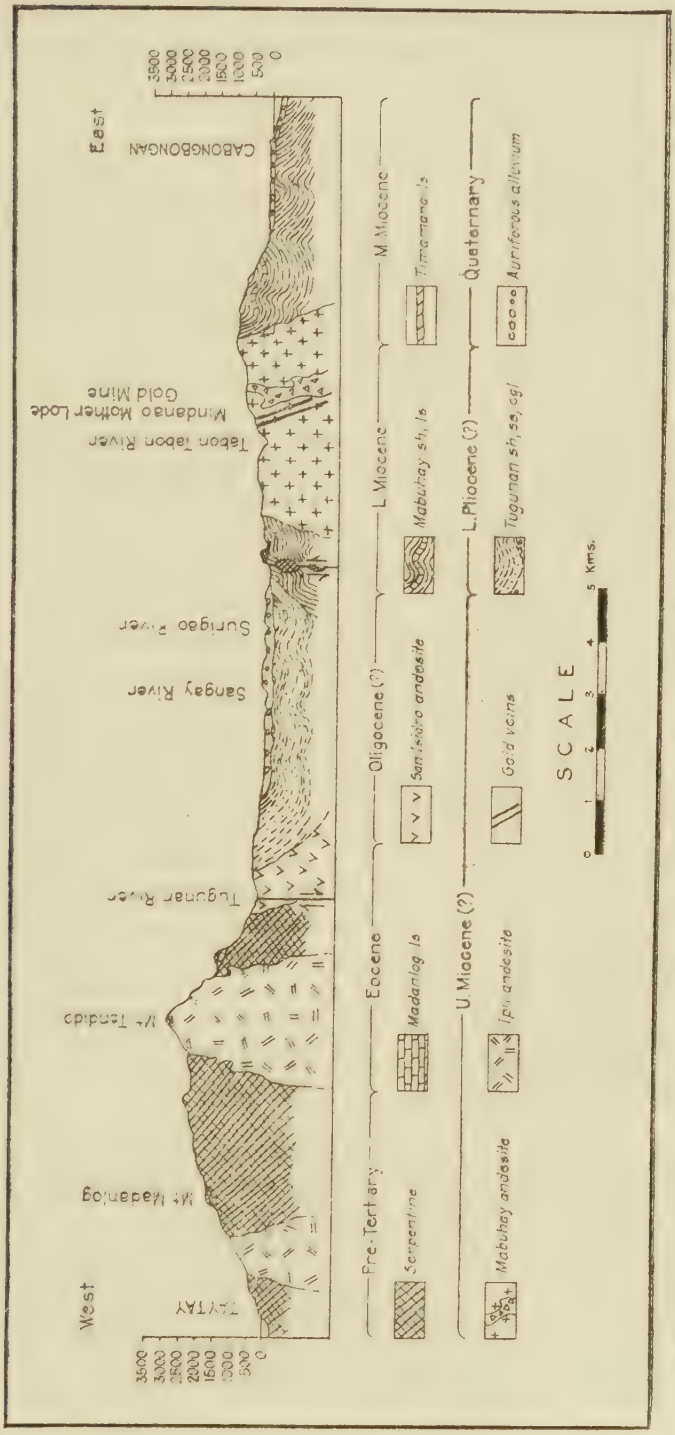

FIG. 5. East-west geologic section through the Surigao Peninsula at the latitude of the Mindanao Mother Lode gold mine (by Luis Santos Yñigo, 1949).

Chromite in serpentine is reported by Frasche (1939) on Calicoan Peninsula of southeastern Samar and on Homonhon Island off the southern coast.

ISLAND OF MINDANAO

Basement rocks crop out in three principal areas: along the eastern Pacific cordillera; as isolated patches in the central part of the island where they are exposed through windows or in deeply etched canyons in the superjacent Tertiary sediments and volcanics; and along the axis of the Zamboanga Peninsula to the west.

PACIFIC CORDILLERA

Northeastern Islands.—The islands of Dinagat, Bucas Grande, Nonoc, and Siargao, off the northeastern tip of Surigao Peninsula, northeastern Mindanao, were studied before the war by field parties under George H. Kemmer. These islands are underlain by serpentinized peridotite. Important chrome deposits occur on Dinagat, and large deposits of lateritic iron ores have developed upon the serpentine of Nonoc and Hinatuan Islands. Upper Tertiary sediments and Recent coral reefs fringe these islands and blanket a large area of Siargao Island.

Surigao Peninsula.—Just before the outbreak of war, Bureau of Mines geologists, under the direction of Mr. Robert Crump, executed a detailed geologic survey of the Surigao gold district. Though all maps and most of the field notes were lost during the Japanese occupation, Mr. Luis Santos-Yñigo (1944) prepared a separate interpretation of the geology of this area.

The oldest rocks of the Surigao Peninsula are composed of metamorphosed clastic sediments and limestones, known as the Sohatan formation, after Sohatan, a village on the western coast of the peninsula. The Sohatan formation is composed of metamorphosed conglomerate, sandstone, marble and schists characterized by various types of amphibole, including glaucophane.

The Sohatan formation has been strongly deformed along north-south fold axes. It is intruded over extensive areas by serpentine along the western range, and smaller areas of serpentine are found on the northern tip of the peninsula, along the Anao-aon River Valley, in the Cansuran placer district, and at Nabago near the northeastern coast of Surigao. Small, widely scattered, exposures of metamorphosed basalt, amphibolite, metadiorite, and metadacite also are reported.

Both the metamorphic rocks and the plutonic intrusives are overlain by the Mt. Madanlog limestone of Eocene age, and by younger Tertiary sediments and volcanics.

Dahican Bay-Cabadbaran Area.—The great lateritic iron-ore deposits of Dahican Bay and vicinity, 90 kilometers south of Surigao, were extensively investigated from 1937 to 1939 by geologists of the National Development Company under the direction of Mr. George H. Kemmer.

The lateritic iron ore deposits overlie a large serpentine mass that extends inland for a radius of more than 20 kilometers from Dahican Bay. Crystalline schists including gneisses, quartz and mica schists, and hornfels, similar to those described by Santos-Yñigo in the Surigao gold ditsrict are found in adjacent areas. There appears little doubt that the serpentinized peridotite of this area has similar intrusive relations to the country rocks as that to the north. West of Mount Legaspi serpentine is overlain by Eocene sediments.

Additional interesting features of the basement geology of this area reported by Kemmer are: eclogite (?) blocks and nodules enclosed in serpentine dikes; blocks of Eocene limestone enveloped and partly metamorphosed by serpentine; peridotite dikes reported to intrude Miocene sediments.

Despite controversies in the interpretation of these findings, the question whether there may be more than one general period of serpentine intrusion in the archipelago is open.

Goodman (Smith, 1924, p. 239) crossed the narrow range between Lake Mainit and the Surigao Sea and found chloritic schists; finely laminated, red and brown slates, in some places interleaved with marble; talc schists; and red jasper.

Central Pacific Cordillera.—Montano made a trip along the east coast of Mindanao and is quoted by Smith (1924, p. 238). In crossing the Pacific cordillera west of Bislig, he found the range at this latitude to consist of "Miocene andesites of great thickness". Between Bislig and Cateel, along the coast, he collected "madrepores altered at the contact with serpentine".

Santos-Yñigo (personal communication) reports that the coastal area between Tandog and Lianga Bay consists of interbedded metavolcanic rocks and argillaceous sediments which strike in a northernly direction. Some of the volcanic rocks possess well-defined pillow structures.

Southeast Cordillera.—West of Pujada Bay, opposite the base of Davao Peninsula, basic and intermediate volcanic rocks are reported altered in part to chloritic schist. From notes by

Goodman, Smith (1924, p. 239) reports that rocks consisting of hornblende diorite and chloritic schists crop out in the area of the Diuata Mountains. A finely laminated mica schist with considerable calcite is also abundant.

In the Davao Gold Mine area near Pantukan, 60 kilometers northeast of Davao, Ira Jaroleman (personal communication) reports that the country rocks consist of andesitic to latitic lava flows with interbedded compact, well indurated, pyroclastics some of which may be as acidic as rhyolite in composition. This sequence is moderately folded along north-south axes and is intruded discordantly by medium to coarse grained diorite. Outside of the mine area itself, considerably deformed, dark gray limestone (Eocene?) appears to overlie the volcanics. From the compact and indurated nature of the pyroclastic volcanics, the volcanic series may be pre-Tertiary, but the diorite intrusives and gold mineralization, which is similar to the Surigao district, are considered to be possibly much younger.

The central part of the Davao Peninsula is composed of serpentine and peridotite. Along the western side of the peninsula, near the village of Piso, Mr. L. J. Sundeen (personal communication) reports chromite and magnesite deposits in these rocks.

CENTRAL MINDANAO

Bukidnon.—On the Sayre highway south of Del Monte, various phyllitic schists, including piedmontite schist, were collected by Grant W. Corby before the war.

Misamis Oriental.—Southwest of Cagayan, a large area of chlorite schist, slate, and phyllite ranging from magnesia-rich to argillaceous and siliceous types, are cut by serpentine masses that contain scattered lenses of chrome ore. The metamorphic rocks occasionally contain small gold-quartz veins.

The oldest known Tertiary formation overlying these rocks is Eocene in age. These sediments are found in Bukidnon Province. Elsewhere the oldest Tertiary formations are Miocene.

Cotabato.—Basement rocks crop out in small areas along the road between Cotabato and Davao to the east, but there is no information on the rock types. Tertiary sediments and recent volcanics are the principal rocks exposed over this vast area.

ZAMBOANGA PENINSULA

A belt of highly deformed chloritic schist, gneiss, slate, and quartzite is reported along the mountainous axis of the Zamboanga Peninsula. Serpentine crops out locally.

A broad area of quartzite is exposed on Mt. Kaladis, west of Malangas, Sibuguey Peninsula. Glenn Brown (personal communication) believes that the quartzite capping of Mt. Kaladis may have been thrust up from the south overriding coal-bearing Miocene sediments of the Malangas coal district. Similar quartzite is found in the Pablo Penao Range north of Zamboanga.

SULU ARCHIPELAGO

Many islands of the Sulu Archipelago stretching between the Zamboanga Peninsula of western Mindanao and northeastern Borneo are composed of volcanics, though some are fringed and several are completely covered by clastic sediments and coral reef formations. The southern Tawi-Tawi Island group, however, is extensively underlain by basement formations, demonstrating that the submerged ridge along which this archipelago is distributed is composed essentially of crystalline rocks, and is not a constructional ridge of recent volcanic origin.

The oldest rocks exposed in the Sulu Archipelago, according to mapping by F. Merchant (Corby, 1940), is serpentine that underlies the northern half of Tawi-Tawi Island and the nearby Tumbagaan, Basbas, and Tagalongan Islands. On the Maraning River, Tawi-Tawi, the serpentine is said to be intruded by gneissoid rocks and by later pegmatites and quartz veins. At Port Languyen, the serpentine reportedly contains small amounts of chromite. The core of Sibutu Island, of the Sibutu group, is reported to consist of diorite.

Metamorphic rocks are found on Baliungan, Tandubato, Dandangan, Tandungan, and Calupag Islands southeast of Tawi-Tawi Island, but have not been described. Maniacola Island, which lies northeast of Tawi-Tawi, is reported to be composed of metamorphic rocks intruded by diorite. The islands of Sugbai and Bubuan are composed of metamorphosed agglomerate. On Tawi-Tawi the metamorphic rocks are reported to overlie the serpentine unconformably, dipping gently to the north, and to attain a thickness up to 1,000 feet. The metamorphics there in turn are overlain by volcanics and sediments.

If it is true that this metamorphic sequence overlies the serpentine, then it follows that some older country rock must exist into which the serpentine was intruded. The intrusion of agglomerate by diorite on Maniacola suggests the possibility that a younger igneous cycle may exist.

The overlying sediments and volcanics have not been dated paleontologically, and there is no basis for ascribing a minimum age to the metamorphic rocks or to the diorite intrusives.

PROBLEMS IN BASEMENT GEOLOGY AND CONCLUSIONS

(1) Nearly fifty years ago George F. Becker stated, "It would seem that from early Paleozoic times onward an archipelago has usually marked the position of these islands. Prior to the Eocene nothing definite is known of them; further investigation will very likely disclose Paleozoic and Mesozoic strata there."

Although Paleozoic and Mesozoic strata are present in the East Indian archipelago to the south and in Formosa and the Japanese archipelago to the north, investigation in the Philippines to date have revealed only that fossiliferous Jurassic and Cretaceous sediments are present. Below these sediments are metamorphic and igneous terrains whose precise geologic age is not known, and because of large distances, geologic correlation with rocks of other areas is yet quite premature. On the other hand, there are large areas of slightly metamorphosed sediments which, when careful search is made, may well yield older fossils. These areas crop out in east-central Luzon, and on the islands of Masbate, Mindoro, Panay, Cebu, Busuanga, and Mindanao.

Axiomatic principles of stratigraphy tell us that all formations of a stratigraphic nature, whether sedimentary or of volcanic origin, whether metamorphosed or not, must have been derived from some pre-existing terrain and deposited upon some pre-existing, and therefore older, floor. Each stratigraphic unit or formation therefore, irrespective whether or not it is cut by deep-seated intrusives, must be succeeded downward in the geologic column by another formation, or series of formations, until some fundamental basement is approached. Until such time that the great variety of metamorphosed formations of the Philippines are carefully unraveled as to sequence, the fundamental basement and the successive episodes of early geologic history must remain in the dim twilight of knowledge of the ancestral Philippines. The great length of geologic time before the Jurassic or Cretaceous periods leads one to suspect that probably many important periods of sedimentation have occurred and these sediments have been involved probably in several great periods of mountain building. Consciousness of this probability is a first prerequisite to a proper geologic frame of mind in approaching the study of these rocks.

(2) The largest iron and all chromite deposits of the Philippines are related to "pre-Tertiary" ultrabasic intrusives; many small copper and cupriferous pyrite deposits are associated with intermediate plutonics; several hypogene manganese deposits occur in metamorphosed argillites, quartzites, and cherts; certain gold deposits are associated with granitoid intrusives, and apically truncated granitic stocks offer promising fields for future prospecting; weathering and erosion of granitic masses result in commercial quartz sand deposits; and granitoid rocks, silicified serpentines or serpentine breccias, and marbles, may provide the basis for polished-stone industries.

The entire metal mining industry of the Philippines, moreover, is largely concerned with ore deposits occurring either within basement formations, or within Tertiary volcanic formations that have been similarly neglected. Whatever the age or ages of metalization, until these areas are properly investigated, many important facts of economic significance will not be available.

(3) From both scientific and economic standpoints, therefore, careful and thorough investigation of basement areas is urgently needed. Comprehensive study of these formations will not be easy. Besides inherent and original complexity, most basement formations have passed through one or more orogenic disturbances, and the resulting structural and metamorphic effects must be evaluated and discounted in order to arrive at proper interpretations. Moreover, because of the archipelagic nature of the islands, and further, because of the extensive Tertiary sedimentary cover, study of these terrains is limited to geologic windows which reduce opportunity for uninterrupted study and continuous geologic correlation of formations. Because of the paucity of fossils, geologic correlation may be limited largely to physical criteria. Nevertheless, by application of time-proven petrologic and petrographic, stratigraphic, and structural methods, assisted by more recently developed techniques including petro-fabric investigations, metamorphic facies studies, igneous cycle and metallogenic studies, and geologic age determinations by radioactivity, much will be learned of these proto-Philippine formations.

(4) From the preceding review, several generalizations appear to emerge:

(*a*) The outstanding geochemical feature of the basement formations is its average basic composition. Peridotites or sepentines, gabbros, and diorites are the prevailing igneous types. Many basic schists probably

are derived from basic volcanics or ultrabasic plutonic intrusives. Although persilicic plutonic rocks are present in the western and northern islands, true granites are so rare as to be considered petrographic oddities. The average basic composition of basement terrains may explain geochemically why chromite, manganese, copper, and iron are the principal base metals produced from the Islands almost to the exclusion of other alloy or base metals, and pegmatitic minerals or metals.

(*b*) In part because of the basic nature of the primary source rocks, the predominant sedimentary rocks of these formations are graywackes or their compositional equivalents. Phyllites and schists of the clay-slate series appear to be the next most common, although bedded cherts which are not to be confused with jaspers of hydrothermal origin, are widespread and occurs as horizons within other sedimentary types, or within volcanic sequences. Quartzites are found mainly in the southerwestern islands. The fact that calcareous sediments are so limited in quantity in contrast to their extensive development in the superjacent Tertiary section, probably like the quartzites, has paleogeographic and paleoecologic significance.

(*c*) Metamorphosed volcanic formations in the basement are becoming recognized with increasing frequency. The general composition and constitution of the known basement formations suggest they are not typically continental or sialic in constitution. Considering the archipelagic nature of the islands, which condition has existed at least during much of Tertiary time, and probably before, this raises the question whether the islands originated by constructional volcanic process from the Pacific floor, or whether the foundation rocks are of tectonic origin and have been elevated from the simic floor of the Pacific Basin. The hypothesis that the Philippine area was once a part of the Asiatic mainland that has since founded, is not considered. The foundering or submergence of a peninsular area, or a land bridge such as Sundaland may have been, on the other hand, does not introduce problems of mechanics as that of continental fragmentation.

(5) Ultrabasic plutonites are widespread and can be expected in any exposed area of basement formations. Careful plotting of occurrences disproves earlier statements that they crop out in two longitudinal belts, one along the eastern and another along the western side of the islands. Plotting shows, instead, that their distribution is related to circumstantial exposure of basement terrain. An accurately prepared map showing distribution of peridotites and serpentines, incidentally, would be of considerable assistance to the prospector who is interested in the metals they may contain, particularly chromite, lateritic iron, and possibly lateritic nickel.

The discovery by Kemmer of possibly two periods of peridotite intrusion in the Surigao iron reservation, Mindanao, poses the question whether the widespread peridotite and serpentine masses of the Philippines are all of the same age. It

is possible that they, as well as other plutonic intrusives, may be of quite different ages in different areas.

(6) Quartz-bearing plutonic intrusives appear to be limited mainly to the area northwest of a line passing from south of Palawan, north of Panay, south of Marinduque and southeast of the Paracale district, Luzon. For want of a better term, this line may be tentatively referred to as the "granite line".

This apparent distribution of quartzose plutonics may have tectonic significance. Structural lineation in the Philippines, although only slightly known, appears to be built up on two systems of arcs. The western islands together with Mindoro and northern Luzon describe an arc of southeastern convexity. The Sulu Archipelago, Zamboanga Peninsula, and west-central Visayan Islands appear to be sympathetically related to this system. The southeastern islands of powerful lineation, describe an arch of northeastern convexity. The first arc may be related to the outer edge of pre-Tertiary and early Tertiary Sundaland. The second arc, judging from metamorphism of Tertiary sediments at a number of localities and from the presence of Tertiary plutonic intrusives in the Paracale and Baguio mining districts, suggests that its present accentuated form, at least, is of late Tertiary age.

(7) Thus far, gold deposits related to pre-Tertiary plutonic intrusion are small and widely scattered. The great gold districts of the Philippines are located along the southeastern arc of late Tertiary age. Powerful gold mineralization along this zone denotes a sharp change in the character of mineralization since "pre-Tertiary" time. Detailed geologic study of this zone conceivably might disclose similar centers elsewhere of intense gold mineralization.

(8) The discovery by Pratt of metamorphosed Tertiary sediments on the Caramoan Peninsula and the observations by Meek in the Paracale district, and by Wisser and Schafer in the Baguio district, that diorite and granodiorite apparently intrude metamorphosed Tertiary sediments provide a sharp warning that metamorphism and plutonic intrusion are not peculiar to "pre-Tertiary" basement formations.

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NOTEWORTHY ADDITIONS TO THE PHILIPPINE FISH FAUNA WITH DESCRIPTIONS OF A NEW GENUS AND SPECIES

By Albert W. Herre [1]

School of Fisheries, University of Washington
Seattle, Washington

and

Earl S. Herald [1]

Steinhart Aquarium, California Academy of Sciences
San Francisco, California

TWELVE TEXT FIGURES

The Philippine Fishery Program of the Fish and Wildlife Service,[2] United States Department of the Interior, is assisting the Philippine Government in the rehabilitation, development, and modernization of the fisheries. Incident to the experimental and exploratory fishing activities, and in connection with the fishery biological investigations many specimens of fishes were collected. Unfortunately a complete survey of the ichthyological fauna is not authorized by law as a part of the program. Nevertheless, a study of the collections made during the year preceding May 30, 1948, disclosed some surprising records and furnished much valuable information concerning certain commercial fishes and about the geographical distribution of others.

The collections made with the aid of electric light at night from the M. V. *Spencer F. Baird* and the M. V. *Theodore N. Gill,* and the examination of the stomach contents of various commercial pelagic fishes have been of particular interest. New and important distributional data about larval and juvenile forms, as well as of adult fishes, were obtained.

[1] Dr. Herre was formerly Ichthyologist and Dr. Herald was formerly Aquatic Biologist, Office of Foreign Activities, Fish and Wildlife Service, and served as members of the staff of the Philippine Fishery Program with headquarters in Manila.

[2] The Philippine Fishery Program of the Fish and Wildlife Service is part of the Philippine Rehabilitation Program of the United States Government authorized by law (50 App. U.S.C., Sec. 1789) and is conducted pursuant to an inter-governmental agreement signed in Manila, March 14, 1947.

Collections from beam trawlers in Manila Bay gave a new genus and species, as well as a number of other fishes previously unknown in Philippine waters, but known to science from other regions. Collections from the fish corrals of the south coast of Batangas Province, Luzon, showed an abundance of noteworthy fishes hitherto unobserved. Knowledge of the presence and capture in commercial quantities of one of these supposedly very rare fishes was one of the most interesting results obtained by a study of native fishing methods.

Most valuable specific and distributional data remain to be gleaned from the catches obtained by trawlers in Philippine waters, and by the native baklad or fish corrals set in water from 40 to 200 feet deep. Careful records and a detailed analysis of these fisheries are needed. Such work should be conducted seasonally over a long term of years in such places as Batangas Province, Luzon; Antique Province, Panay; Zamboanga Province, Mindanao, Basilan Island, and in fact wherever the fishing methods mentioned above are in operation.

The Checklist of Philippine Fishes by the senior author (in press) gives 2,145 species thus far known from Philippine waters. This very large number is by no means the total fish fauna occurring within the limits of the Philippine Islands. It will be a very long time before the entire Philippine fish fauna is completely known, and surprising additions may be looked for during the coming years. Great stretches of coastline have never had any scientific collections of fishes made in their waters, while the fresh-water streams of most of the islands are imperfectly or not at all known. A few months devoted to intelligent and intensive collecting in certain localities could easily add fifty species to the Philippine fish fauna.

Unless otherwise specified all lengths given are in standard length.

Family OPHIDIIDÆ

Genus UMALIUS Herre and Herald

Lepophidium Umali, Philip. Jour. Sci. **56** (1935) 323; not of Gill.

Only one species known as yet, and thus far not taken outside the Philippines.

Body elongate, moderately curved, the body ending posteriorly in a point, scales cycloid, imbricated; the conspicuous lateral line concurrent with the back, ending a slight distance before the

FIG. 1.

caudal, but probably complete in life; opercle with a sharp spine, not concealed; no spine on the prominent snout; mouth oblique, inferior; teeth in three rows anteriorly and two rows laterally, all teeth sharply pointed, curved, movable, and immersed in a papillose membrane; a strong band of small stout teeth on vomer and on palatines.

Type *Umalius philippinus* Herre and Herald, new species. This genus is close to *Lepophidium* and *Otophidium* Gill, but differs especially in the dentition and opercular spine. Named for Mr. A. F. Umali, able and zealous student of Philippine fishes and fisheries.

UMALIUS PHILIPPINUS Herre and Herald **Fig. 1.**

Lepophidium marmoratum Umali, Philip. Jour. Sci. **56** (1935) 323, *plate 1, fig. 3*, not of Goode and Bean.

Divisoria Market, Manila, Luzon.

Dorsal about 89; anal about 64; pectoral 24; scales along lateral line about 82; gill rakers on first gill arch short, somewhat curved, stout; gill raker formula 0 + 4; rounded tubercles between rakers are 4 + 6.

The compressed elongate body is deepest at the origin of the first dorsal, the dorsal and ventral outlines tapering uniformly to the caudal, the depth 5.4 times in the length. The head is large, 4.2 times in the head, and longer than the snout. The snout equals the interorbital and is 4.28 times in the head. The inferior mouth is moderately large, the maxillary extending a little beyond the hind margin of the eye, 2.14 in the head, with its posterior extremity broad; the opercle ends in a rather stout sharp spine, which extends almost to the margin of the opercular flap.

The cycloid imbricate scales are embedded with only that part in the scale pocket visible; they are largely deciduous; the whole body is covered with scales except the snout and under side of the head; the dorsal and anal are low and confluent with the caudal; the pectorals are short and equal to one and seven-eighths of the head; the ventrals are slightly longer than the pectorals; the anus is almost in the middle of the length.

The color in alcohol is yellow or yellowish, with four dusky brown bands as follows: one from the origin of the dorsal passing subdorsal along the back and extending nearly to the caudal; two broad bands of the same color cross the nape and

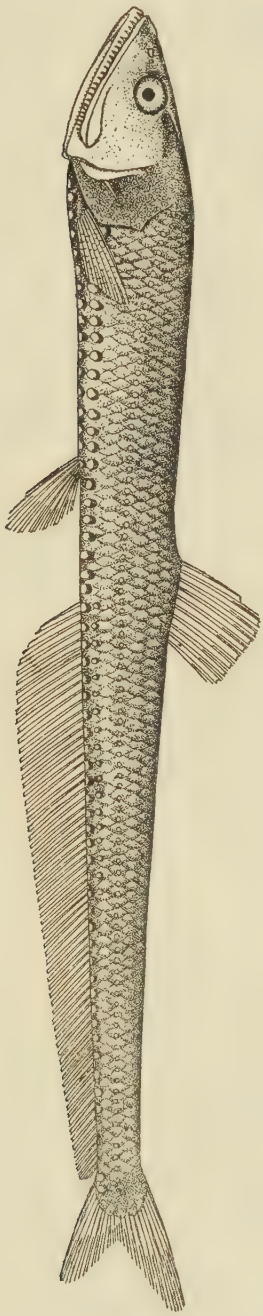

FIG. 2.

descend obliquely to the belly, the posterior one sending a stripe of brown along the lateral line; a broad dark brown blotch covers the interorbital space and sends an oblique band along the hind margin of the eye to the posterior angle of the opercle. The dorsal is cream color, with 5 large semicircular black spots on the upper half of its anterior two-thirds and the rest of the fin and the anal with a broad blackish longitudinal band and narrow pale margin. The pectorals are nearly colorless, probably yellow in life, specled with minute dusky dots; the ventrals are very pale yellowish.

Here described from the type and sole specimen, 126 mm. long. It was taken by a beam trawler from Manila Bay in 13 to 25 fathoms, June, 1947. This is the second Philippine specimen collected and the only one known at present. Umali's specimen was lost when the Japanese wantonly destroyed the Bureau of Science.

Family MAUROLICIDÆ

Genus DIPLOPHOS Günther

DIPLOPHOS TAENIA Gunther. **Fig. 2.**

Five specimens, 34 to 41 mm. in length, were taken in the Sulu Sea by surface plankton tow net at night, at Lat. 6° 48.5′ North and Long. 118° 51.5′ East. This species was previously known from the tropical and southern Atlantic and Indian oceans.

Measurements and counts of the 5 specimens are as follows:

Total length	34	36	38	40	41
Dorsal rays	10	10	10	10	11
Anal rays	59	60	61	59	60
Pectoral rays	9	9	9	9	9
Lower row photophores	102	101	97	103	100
Upper row photophores	67	66	66	68	69
Lateral line	89	89	91	92	92

Barnard, in Annals South Africa Museum, vol. 23, p. 149, mentions a suborbital and three opercular photophores, as well as smaller ones on the upper and lower jaws. These are not visible in the specimens at hand.

According to Parr's study of *Diplophus* (Bull. Bingham Oceanogr. Coll., vol. 2, art. 4, p. 11, 1926) *D. tænia* Günther is most easily segregated from *D. pacificus* Günther on the basis of the anal ray count, the former species having 58 to 61 rays and the latter 53 rays.

Family NETTASTOMIDÆ

Genus CHLOPSIS Rafinesque

CHLOPSIS FIERASFER Jordan and Snyder

A specimen 445 mm. long was taken by a beam trawl operating in Manila Bay near Corregidor Island, at a depth of 19 to 29 fathoms, June 10, 1947. The first Philippine record and a surprising find. This species has been known hitherto from deep water near Japan.

Family MORINGUIDÆ

Genus MORINGUA Gray

MORINGUA BICOLAR Kaup

A specimen was taken while fishing with electric light at Masinloc anchorage east of Zamboanga City, Zamboanga Province, Mindanao. The first Philippine record and a notable extension of its range. This fish has been known previously from Flores and Timor in the East Indies, New Britain in the Bismarck Archipelago, and Kandavu, one of the Fiji Islands.

MORINGUA CAGAYANA Seale

A specimen 580 mm. long of this unique eel was taken at Caldera Bay, Zamboanga Province. The type, destroyed by the Japanese when they eliminated the Bureau of Science, was for many years the only specimen known. In 1940 I obtained 2 at Dumaguete, and this makes the third specimen now available.

Family PARALEPIDÆ

Genus LESTIDIUM Gilbert

LESTIDIUM PHILIPPINA (Fowler)

A number of examples up to 163 mm. in length, were obtained in Batangas and other markets of Batangas Province, Luzon. The only other specimens known are the type and five paratypes taken by the *Albatross* on the opposite side of Verde Island Passage, at Varadero Bay, Mindoro. The species does not appear to be uncommon in the nightlight catches along the Batangas coast.

Family BREGMACEROTIDÆ

Genus BREGMACEROS Thompson

BREGMACEROS MCCLELLANDI Thompson

Three specimens 81 to 83 mm. in length were taken by trawl from Manila Bay, June to September, 1947, in 19 to 29 fathoms of water. Not uncommon in the nightlight catches taken in Balayan and Batangas Bay. This little fish was first recorded

from the Philippines by Günther in 1862. No other specimens have been noted, although Günther's record has been copied by other authors, and Weber and de Beaufort listed the species as "near Philippines". These are therefore the second positive Philippine records.

Family SOLEIDÆ

Genus ASERAGGODES Kaup

ASERAGGODES FILIGER M. Weber

A typical specimen 100 mm. long was taken by beam trawl from Manila Bay within 8 miles of Corregidor Island, in 13 to 25 fathoms of water, June 27, 1947. This is the first Philippine record. Previously known only from the Java Sea, off Pekalongan, Java, and from the island of Rotti, Dutch East Indies.

Family MONOCENTRIDÆ

Genus MONOCENTRIS Bloch and Schneider

MONOCENTRIS JAPONICUS (Houttuyn)

Five specimens of this remarkable fish were taken by the *Theodore N. Gill,* using an otter trawl just outside Manila Bay in 65 fathoms. They were from 100 to 162 mm. in length. Since then more specimens have been taken by other trawlers and the fish seems to be not rare in Philippine waters. Originally described from Japanese waters, it is also known from the coast of China, the Dutch East Indies, the Andaman Islands, Mauritius, and the east coast of Africa.

Family SYNGNATHIDÆ

Genus HALICAMPUS Kaup

HALICAMPUS GRAYI Kaup

This species was obtained from the stomachs of the yaito tuna, *Euthynnus yaito,* caught by trolling on two occasions in January, 1948, near Pilas Island, west of Basilan Island, in the Sulu Sea. One pipefish was taken on January 7 and 30 more pipefish were taken from the stomachs of four yaito tuna on January 14. The longest of these pipefish was 70 mm. long.

These specimens all fall within the limits of the species as defined by Duncker and by Weber and DeBeaufort, Fishes of the Indo-Australian Archipelago, 4 (1922) 103, *fig. 43.* They present one notable difference. The figure referred to above shows a species with a short snout, 2.7 times in the head. All our specimens are with a proportionately long snout, which is

FIG. 3.

contained but twice in the head. It would require comparison with museum material not available at the time of this writing to determine the significance of this difference.

This is the second Philippine record. It was described by Alvin Seale under the name of *Trachyrhamphus caba* Seale and was from Balayan Bay, Batangas Province, Luzon. (The Philippine Journal of Science, vol. 4, sect. A, p. 503, 1909).

This pipefish is known elsewhere from the Andaman Islands, Japan, New Guinea, Thursday Island, Prince of Wales Island, and Northwest Australia.

Genus YOZIA Jordan and Snyder

YOZIA BICOARCTATA (Bleeker)

A male specimen 213 mm. long, with embryos in its brood pouch, was taken from Manila Bay by otter trawl in 18 fathoms of water, November 20, 1947. This is the first and only Philippine record.

Length 213 mm.; head 20.5 mm.; snout 10.4 mm.; dorsal fin base 14.8 mm.; dorsal rays 28; pectoral 18; anal 4; caudal 9. The dorsal lies above 3 trunk rings and 2 tail rings. The brood pouch is beneath 19 tail rings.

Previously known from China, Japan, Singapore, Sumatra, Amboina, the east coast of Africa, and Mauritius.

Family TRACHYPTERIDÆ

Genus TRACHYPTERUS Gouan

TRACHYPTERUS MISAKIENSIS Tanaka Fig. 3.

One specimen 90 mm. in length was taken under the night-light eight miles south of Pilas Island, Sulu Archipelago at Lat. 6° 26′ North; Long. 121° 35′ East. This is the first Philippine record and is believed to be the fifth known specimen, the other four being the original types. Pertinent data on this specimen are as follows: total length 99 mm.; dorsal 3, 112; caudal 8; pectoral 10; ventral 8; lateral line 165; gill rakers $3 + 1 + 7 = 11$; the asymmetrical anal pore located on the left side is of considerable interest. Mr. Donald E. Kauffman has kindly made available the following color notes taken at the time the specimen was brought aboard the M. V. *Theodore N. Gill:* "Body metallic silver with light black round spots extending from head to caudal peduncle above lateral line, the posterior ones becoming slightly larger, irregular and indistinct. Dorsal rays brilliant salmon color for four-fifths the length of the fin, the remaining one-fifth faintly pink. Ventrals pinkish

with very delicate filmy appearance. Pectorals hyaline. Caudal bright salmon."

Since the trachypterids are noteworthy for their change in body proportions from juvenile to adult, it was necessary to graph all characters of the types in order to compare them with the Philippine specimen. From these rough plots it appears very probable that one of the two smaller paratypes is a different species from the remaining types. To which of these possible species the Philippine specimen belongs cannot be determined without re-examination of the original material.

Allowing for growth changes the Philippine specimen differs most markedly from the type illustration of *T. misakiensis* in (1) eye-in-head value; (2) longest ventral-into-standard length value; (3) free ray count of the dorsal; (4) asymmetrical versus symmetrical anal pore; (5) and in the arrangement of the lateral pore system.

Family THUNNIDÆ

Genus AUXIS Cuvier

AUXIS TAPEINOSOMA Bleeker

Previously it was thought that but one species of frigate mackerel, *Auxis thazard,* occurred in Philippine waters. Our studies show that two species are present, and we believe them identical with Kishinouye's *Auxis hira* and *Auxis maru. Auxis hira* is probably a synonym of *Auxis thazard* Lacépède and *A. maru* seems to be a synonym of *Auxis tapeinosoma* Bleeker. The status of these names, as well as that of *Auxis rochei* can be settled only by a re-examination of the types of these species, as well as by detailed study of the frigate mackerel populations in the areas in which they occur. At present we apply the name *Auxis thazard* in the Philippines to the species with fewer gill rakers and *Auxis tapeinosoma* to the species with a larger number of gill rakers. As first indicated by Kyshinouye the width of the corselet along the lateral line is often enough to differentiate adults of the two species in the field. Table 1 presents the gill raker counts for the two Philippine species of *Auxis* as well as a sample of the Atlantic American population which has been known under the specific name of *thazard.* From this table it is apparent that insofar as gill rakers are concerned the Atlantic *thazard* are slightly different from the Philippine *thazard* and the difference is greatest on the lower arch. The Atlantic specimens of *A. thazard* which were examined were all contained in the collection of the U. S. National Museum.

TABLE 1.—*Comparison of gill raker counts of Philippine and Atlantic American frigate mackerels*

Gill rakers		Auxis thazard		Auxis tapeinosoma
		Philippine	Atlantic American	Philippine
Upper arch	7	3		2
	8	0	3	2
	9	21	12	3
	10	21	7	75
	11			74
	12			5
Center	1	51	22	161
Lower arch	28	1		
	29	14		
	30	21	5	
	31	13	4	1
	32	2	6	17
	33		6	38
	34		1	53
	35			30
	36			19
	37			3
Total rakers	38	3		
	39	8	1	
	40	18	2	
	41	12	7	2
	42	9	3	2
	43	1	5	13
	44		4	28
	45			40
	46			37
	47			20
	48			13
	49			3
	50			3
Number of specimens		51	22	161
Fork length size range		51-441 mm	255-345 mm	53-217 mm
No. localities represented		5	4	4

Family GEMPYLIDÆ

Genus RUVETTUS Cocco

RUVETTUS PRETIOSUS Cocco **Oil Fish**

A specimen weighing 10 pounds was observed in the market at Zamboanga, Mindanao, March 9, 1948. The Samal name for the oil fish is ulago. This was said to be the first specimen brought to the Zamboanga market for nine years. However, people were well acquainted with the remarkable purgative effect of the flesh of this fish. This is the second Philippine occurrence to come to our attention, the first being observed

by Herre who found three specimens in the Manila market. They had been caught along the north coast of Camarines Norte Province, Luzon. The species occurs at depths of about 300 meters to perhaps a kilometer and therefore is not commonly taken by Philippine fishing methods. Circumtropical in distribution and originally described from the Mediterranean.

Genus JORDANIDIA Snyder

JORDANIDIA PROMETHEOIDES (Bleeker) **Fig. 4.**

Ten examples 168 to 190 mm. in length were obtained during April and May, 1948, from the markets of Batangas, Lemery, and Taal, Batangas Province, Luzon. Three additional specimens, 75 to 145 mm. in length, were taken from the stomach of a specimen of *Katsuwonus pelamis* caught in Moro Gulf, south of Zamboanga Province, Mindanao, at approximately Lat. 7° North and Long. 123° 49′ East.

This fish is not uncommon in the markets along the Batangas coast during March, April, and May. The people believe it to be the young taniging bato, *Acanthocybium solandri.* It is usually attracted by light at night and taken in the basnig nets of Balayan and Batangas bays, Batangas Province, Luzon. Known from the East Indies to the Bay of Bengal.

Genus GEMPYLUS Cuvier

GEMPYLUS SERPENS Cuvier and Valenciennes **Snake Mackerel**

A specimen 540 mm. long was caught while fishing with a night light from the M. V. *S. F. Baird* in the Sulu Sea at Lat. 9° 44′ North, and Long. 120° 33′ East. A second specimen 160 mm. long was obtained from the stomach of a skipjack, *Katsuwonus pelamis,* caught in the Celebes Sea east of the Sulu Archipelago at Lat. 5° 20′ North, and Long. 123° 7′ East, on March 9, 1948. New to the Philippines but widely distributed in the open Atlantic, Pacific, and Indian Oceans.

Family ISTIOPHORIDÆ

Genus ISTIOPHORUS Lacépède

ISTIOPHORUS ORIENTALIS Schlegel **Sailfish Fig. 5.**

A specimen 159 mm. long was taken in the Sulu Sea while fishing with electric light, December 5, 1947, at Lat. 6° 57′ North and Long. 121° 2′ East. A second juvenile specimen 445 mm. long was caught while fishing at night from the M. V. *S. F. Baird* in the Celebes Sea west of Cotabato Province, Mindanao, at Lat. 6° North and Long. 123° East, on March 9, 1948.

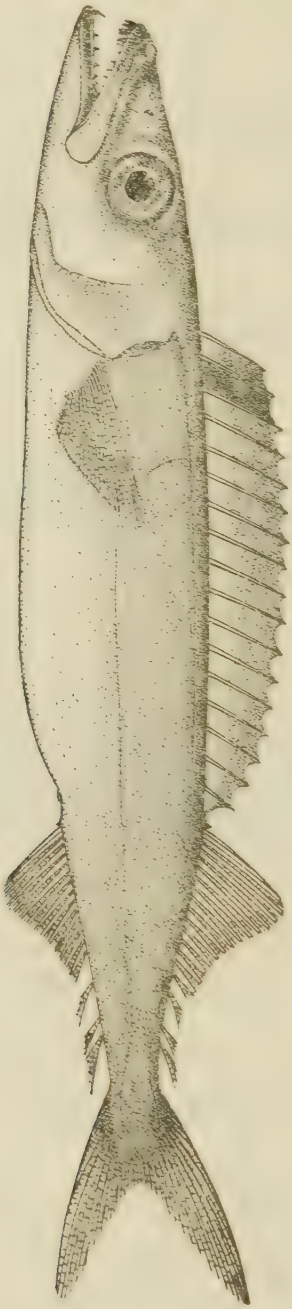

FIG. 4.

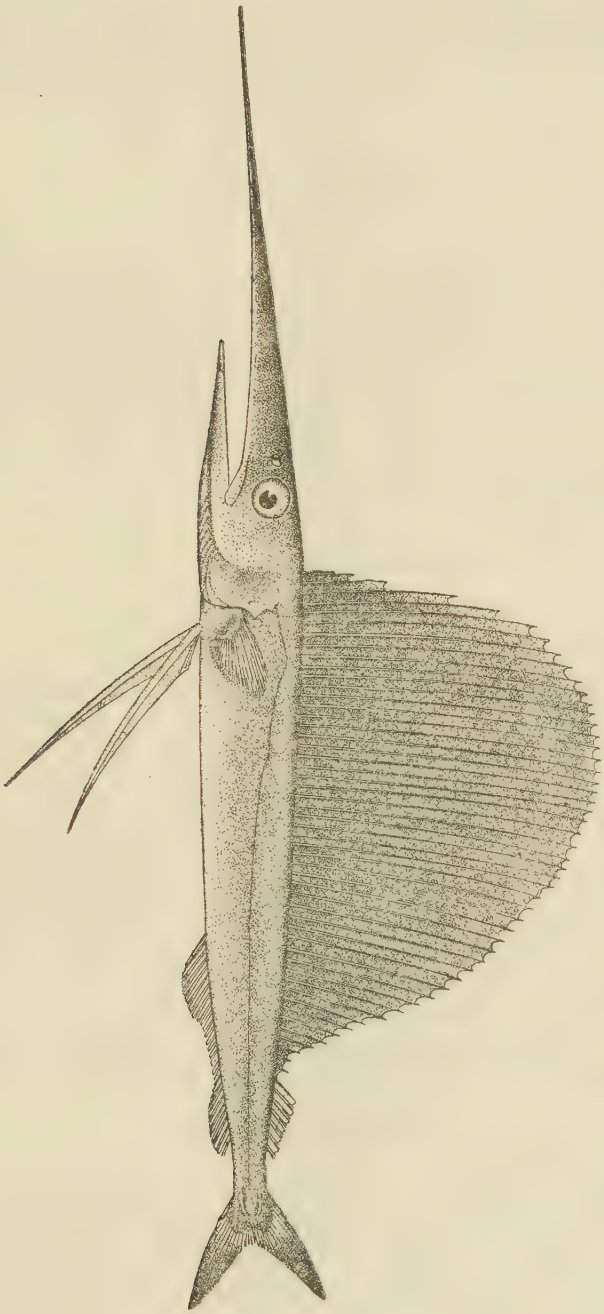

FIG. 5.

Istiophorus orientalis the sailfish, is common in the Philippines and many are taken by sport and commercial fishermen, but the above are the first juvenile examples known from the islands. First described from Japan, it is known eastward to Hawaii and southward through the East Indies.

Family XIPHIIDÆ

Genus XIPHIAS Linnaeus

XIPHIAS GLADIUS Linnaeus **Swordfish Fig. 6.**

Two juvenile specimens, 41 and 44 mm. in length, were taken in the Sulu Sea while fishing with a light from the M. V. *S. F. Baird* at Lat. 7° 21′ North and Long. 119° 27′ East. The swordfish is known from many records in the Philippines and many are caught every year by Filipino and American fishermen, both professionals and amateurs, but these are the first larval specimens known from Philippine waters. Found in all warm seas.

Family NOMEIDÆ

Genus NOMEUS Cuvier

NOMEUS GRONOVII (Gmelin) **Fig. 7.**

The illustrated specimen is 30 mm. in length and was taken by nightlight fishing in the Sulu Sea, Lat. 8° 27.5′ North and Long. 119° 34′ East. One other specimen 25 mm. in length was taken by nightlight in the Celebes Sea, Lat. 4° North and Long. 124° East. When this latter specimen came within the beam of the nightlight, it was at first mistaken for a flying fish as the widely expanded black ventrals simulated the pectorals of the short-winged flying fishes which were common in the area. It should be noted that the color pattern as well as the curvature of the throat is entirely different from that illustrated in Goode and Bean's Oceanic Ichthyology (1895, p. 220, fig. 227). This is the first Philippine record although the species has previously been known from the Atlantic and Indian Oceans.

Genus CUBICEPS Lowe

CUBICEPS GRACILIS Lowe

Twenty-three specimens 75 to 138 mm. in length were bought in the Lemery and Taal markets, Batangas Province, Luzon, in April, 1948. This fish is not uncommon on the Batangas coast, where it is known as "Iso." It is taken at night with the basnig, a lift net to which fish are attracted by a powerful lantern.

FIG. 6.

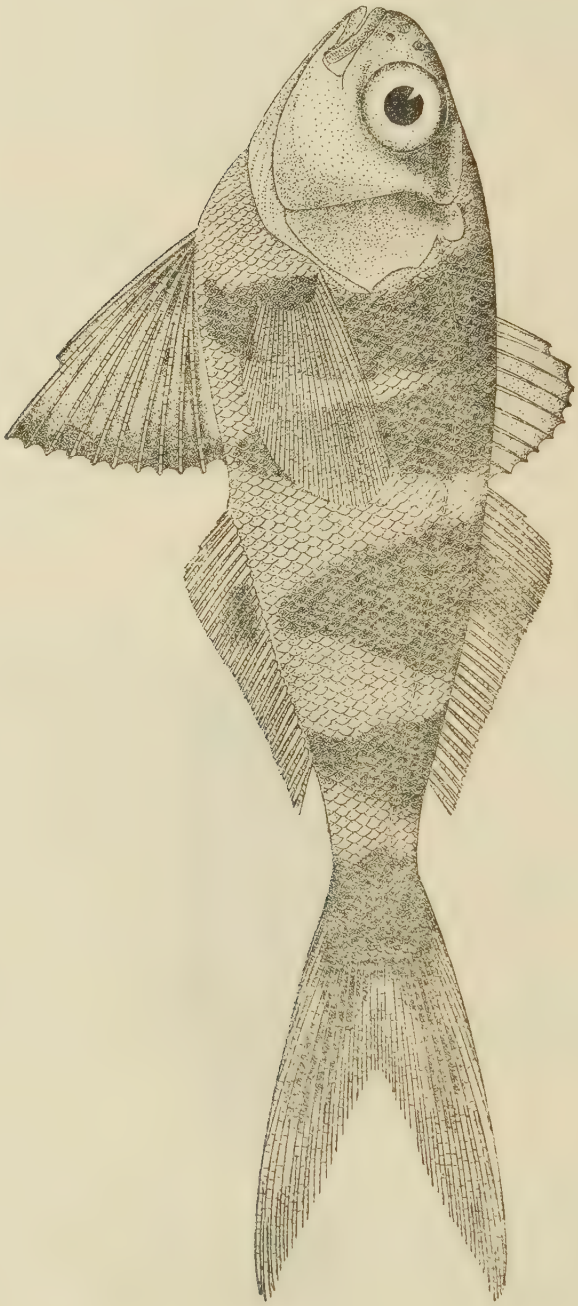

FIG. 7.

Dorsal XI—I—22; anal III—20 to 22; lateral line 66; gill rakers 4 + 13.

Another specimen 53 mm. long was taken in the Sulu Sea while fishing with a light south of Pilas Island, which lies west of Basilan Island.

This fish was originally described from the island of Madeira. It has also been taken in the Mediterranean off Sicily and in the Atlantic between Madeira and the Azores. It has been recorded doubtfully from the Cape of Good Hope. This is not only the first record from the Philippines but is a notable find in the discovery that this fish, hitherto known only from a few specimens taken on the other side of the world, is being caught commercially in Balayan Bay, where it is well known to the fishermen and market people. We may expect it to occur in equal abundance in the Sulu Sea and elsewhere in Philippine waters where basnig fishing is employed.

Family CORYPHÆNIDÆ

Genus CORYPHAENA Linnaeus

CORYPHAENA EQUISETIS Linnaeus **Little dolphin Fig. 8.**

Twenty-nine juvenile specimens from the Sulu Sea, Sulu Islands, and Celebes Sea, their lengths 19.5 to 161 mm.

Many young dolphins were attracted to the light when hydrographic stations were run at night from the M. V. *S. F. Baird.*

TABLE 2.—*Comparison of meristic characters of the Philippine Coryphæna*

	Dorsal rays													Anal rays							Number Specimens
	49	50	51	52	53	54	55	56	57	58	59	60	61	23	24	25	26	27	28	29	
equisetis	2	5	4	13	11	5	2	1							4	21	10	9			45
hippurus										2	7	3	1	2	2	2	3	2	1	2	14

Gill rakers

	Upper arch		Center	Lower arch										
	2	1	1	1	2	3	4	5	6	7	8	9	10	
equisetis	3	34	37								9	19	9	37
hippurus		1	16							5	6	5		16

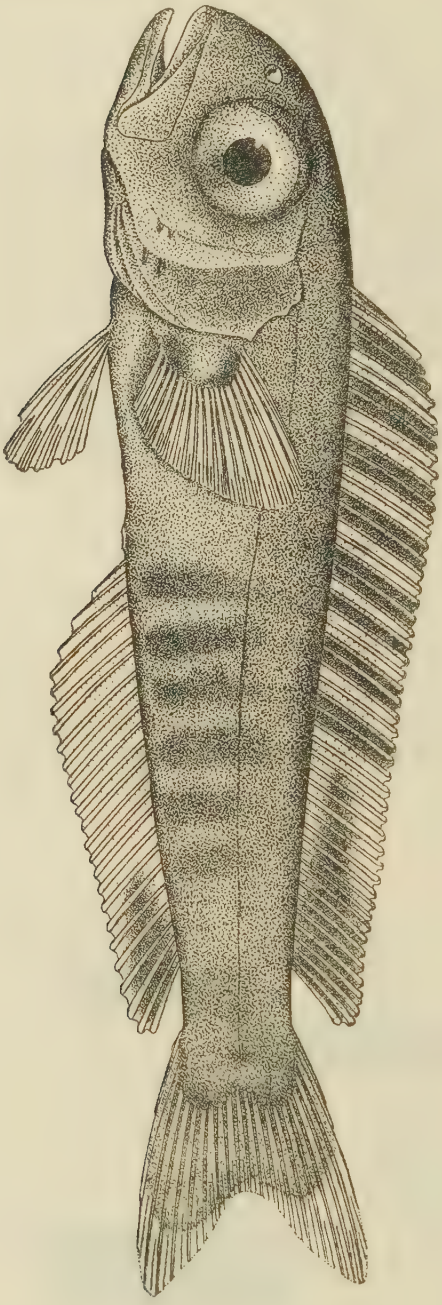

FIG. 8.

At first they were all referred to as *Coryphaena hippurus* as that was the only species recorded from the Philippines. However, examination showed that most of the juvenile specimens were of a different species from the adults commonly caught by trolling.

The best characters for separating the two species are the dorsal rays and the gill rakers, as shown in Table 2. Forty-three specimens of *C. equisetis* examined have 49 to 56 dorsal rays, while 14 spicemens of *C. hippurus* have 58 to 61 dorsal rays. *C. equisetis* always has at least one, and sometimes two gill rakers on the upper arch. *C. hippurus* usually has no gill rakers on the upper arch. Examination of 16 specimens of the latter species showed but one fish with a gill raker on the upper arch. The center gill raker between the upper and lower limbs of the gill is always present in both species.

Of 46 juveniles taken at sixteen different stations only two belonged to *Coryphæna hippurus*, all the rest being *C. equisetis*. The two young specimens of *C. hippurus* are 43 and 172 mm. in length. All other examples of *C. hippurus* to *C. equisetis* is approximately the same as the ratio found by Lutken in the Atlantic Ocean, as reported by Goode and Bean; Oceanic Ichthyology, p. 209, 1895. It may be possible that the young of *C. hippurus* are usually limited to deep water although evidence for such a hypothesis is not yet available.

There are seven localities from the Sulu Sea, three from the Celebes Sea, and one from Moro Gulf, which is a part of the Celebes Sea. The species are pelagic, and found in all warm seas.

TABLE 3.—*Locality records for Coryphæna equisetis Linnæus in Philippine and adjacent waters.*

Station number	Date	Number specimens	Mm Range standard length	Latitude	Longitude
B-48	12-4-47	2	19.5-34	8° 27.5′ N.	119° 34′ E.
B-51	12-4-47	2	63-107.5	6° 57.5′ N.	121° 02.5′E
B-54	12-5-47	2	67-122	6° 44′ N.	120° 06′E.
B-57	12-6-47	1	66	8° 32′ N.	118° 20′ E.
B-64	12-10-47	1	76.5	6° 48.5′ N.	118° 51′ E.
B-117	3-1-48	1	32.7	5° 18′ N.	125° 30′ E.
B-139	3-9-48	5	45-61	5° N.	123° E.
B-141	3-9-48	3	124-161	6° N.	123° E.
G-47	4-13-48	8	36-57	10° 27.5′ N	121° 54.4′E
G-55	4-13-48	2	75-92	6° 26′ N.	121° 35′ E.
G-56	4-15-48	2	32-45	6° 46.7′ N	122° 21.5′E

Records adjacent to the Philippines

Station number	Date	Number specimen	Mm. Range standard lenght	Latitude	Longtitude
					4° E.
B-128	3-4-48	2	39-43.5	4° N.	12
B-136	3-8-48	2	25-29	3° N.	123° E.
B-156	4-10-48	10	41-155	2° N.	121° E.
B-167	4-13-48	1	174	3° 01′ N.	118° 49.5′E

Family CARANGIDÆ

Genus NAUCRATES Rafinesque

NAUCRATES DUCTOR Linnaeus

One specimen 69 mm. in length was taken at Sibuguey Bay, Zamboanga Province, Mindanao and another 23.5 mm. in length was taken in the Celebes Sea, Lat. 4° North and Long. 124° East. One previous Philippine specimen recorded by Herre from Manila Bay.

Family LUTIANIDÆ

Genus PRISTIPOMOIDES Bleeker

PRISTIPOMOIDES TYPUS (Bleeker)

Many specimens up to two feet in length are taken by the fishermen of Nasugbu fishing in the vicinity of Fortune Island near the entrance to Manila Bay. Previously recorded by Herre from Miagao, Iloilo Province, Panay.

Family PRIACANTHIDÆ

Genus PSEUDOPRIACANTHUS Bleeker

PSEUDOPRIACANTHUS NIPHONIUM (Cuv. and Val.)

Several specimens were taken by trawl at the mouth of Manila Bay, in 65 fathoms. The only specimen measured was 143 mm. long. This is the first Philippine record of this fish, which was originally described from Japan. It is also known from Menado, Celebes, and from Reunion and Mauritius islands in the Indian Ocean.

Family APOGONIDÆ

Genus HOWELLA Ogilby

HOWELLA BRODIEI Ogilby **Fig. 9.**

A 58 mm. specimen was taken from the stomach of a dolphin (*Coryphæna hippurus* L.) which was caught in the Celebes Sea east of Tawi Tawi, Sulu Province; Lat. 5° 12′ North, and Long. 121° 57′ East.

First dorsal VIII; second dorsal I–9; anal 9; pectorals 14; caudal rays 18; spines above caudal base 7, below 7; 33 scales in lateral line with a ventral bend in the line between the 9th

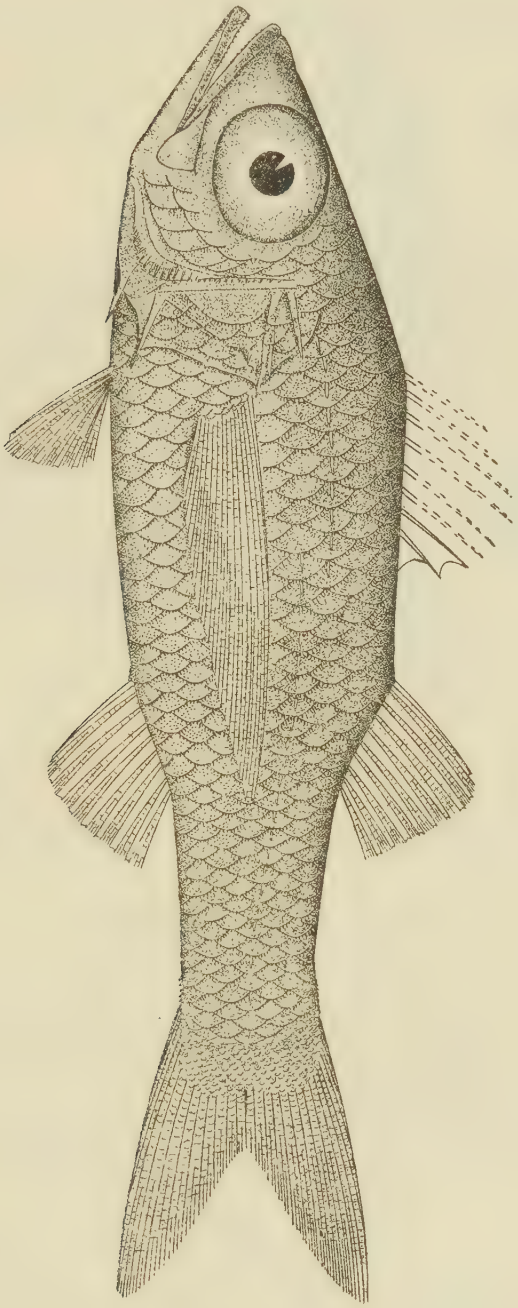

FIG. 9.

and 10th scales; gill rakers $7 + 1 + 19 = 27$. Previously known only from Lord Howe Island east of New South Wales, Australia.

This species is likewise a very unexpected and surprising addition to the Philippine fish fauna.

Family SERRANIDÆ

Genus ANTHIAS Bloch

ANTHIAS ALBOFASCIATUS Fowler

Two examples, 57 and 72 mm. in length, were taken by otter trawl in the north entrance to Manila Bay. They were found in 27 to 31 fathoms of water near Los Cochinos Point, Bataan Province, November 25, 1947.

Previously known only from the type taken by the *Albatross* in the China Sea, northwest of Luzon and outside Philippine waters, and from two specimens collected by Herre at Puerto Galera, Mindoro.

Family NEMIPTERIDÆ

Genus NEMIPTERUS Swainson

NEMIPTERUS MARGINATUS (Cuvier and Valenciennes)

We have examined three specimens all about 145 mm. in length, from the north entrance to Manila Bay. They were caught in an otter trawl in 30 fathoms of water, off Los Cochinos Point, Bataan Province, November 25, 1947.

Previously known only from Java, Makassar and Bulukomba in Celebes, and Vanikolo, Santa Cruz Islands. New to the Philippines.

Family HISTIOPTERIDÆ

Genus HISTIOPTERUS Schlegel

HISTIOPTERUS TYPUS Schlegel Fig. 10.

A fine specimen 240 mm. long was taken by the M. V. *T. N. Gill,* 5 miles northwest of Fortune Island, Batangas Province. A second specimen was 93 mm. long.

This noteworthy find is the first record for this fish outside Japanese waters, where it is a food fish, but not abundant.

Family ANTIGONIIDÆ

Genus ANTIGONIA Lowe

ANTIGONIA MALAYANUS M. Weber

Many specimens up to 60 mm. in length were taken by otter trawl, worked by the M. V. *T. N. Gill,* in 60 fathoms. They were caught October 2, 1947, about 5 miles northwest of For-

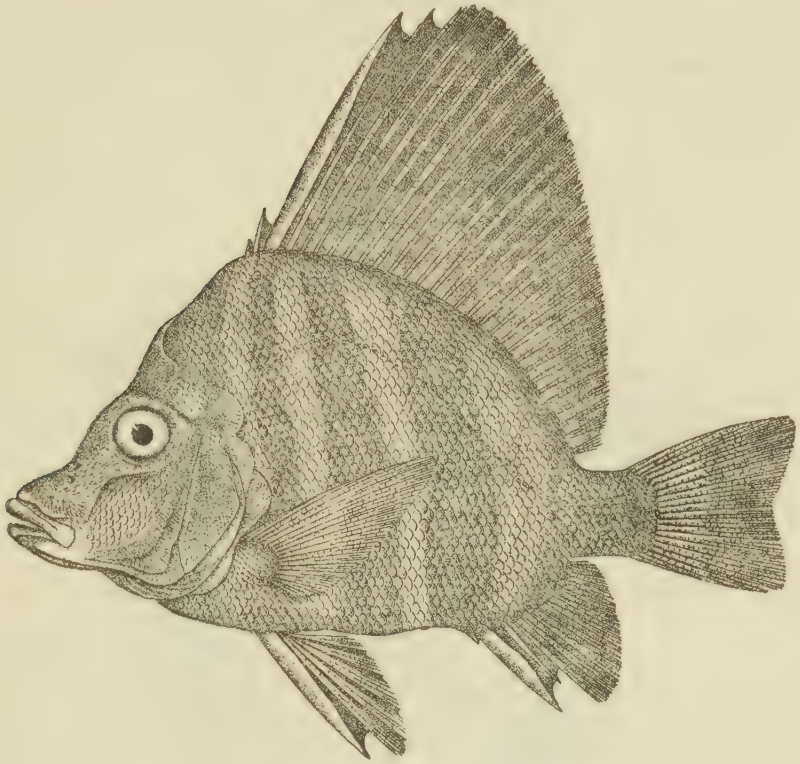

FIG. 10.

tune Island, Batangas Province, Luzon. Previously known only from the Arafura Sea; this is another fine addition to the Philippine fish fauna.

Family SCORPÆNIDÆ

Genus AMBLYAPISTUS Bleeker

AMBLYAPISTUS MACRACANTHUS (Bleeker)

A specimen 66 mm. long was taken by a beam trawler in Manila Bay, within 8 miles of Corregidor Island on June 27, 1947, in 13 to 25 fathoms of water. This is the first Philippine record of this rare fish, which has previously been known only from Amboina and Ceram, Dutch East Indies.

Genus APISTUS Cuv. and Val.

APISTUS ALATUS Cuvier and Valenciennes

A specimen 75 mm. long was taken by the otter trawl of the M. V. *T. N. Gill,* October 28, 1947. This addition to the Philippine fish fauna was caught 7 miles southwest of Corregidor

Island, off the coast of Cavite Province, Luzon. It was originally described from Madras and Bengal, India, and is also known from the coasts of China and Japan, and from Batavia, Java.

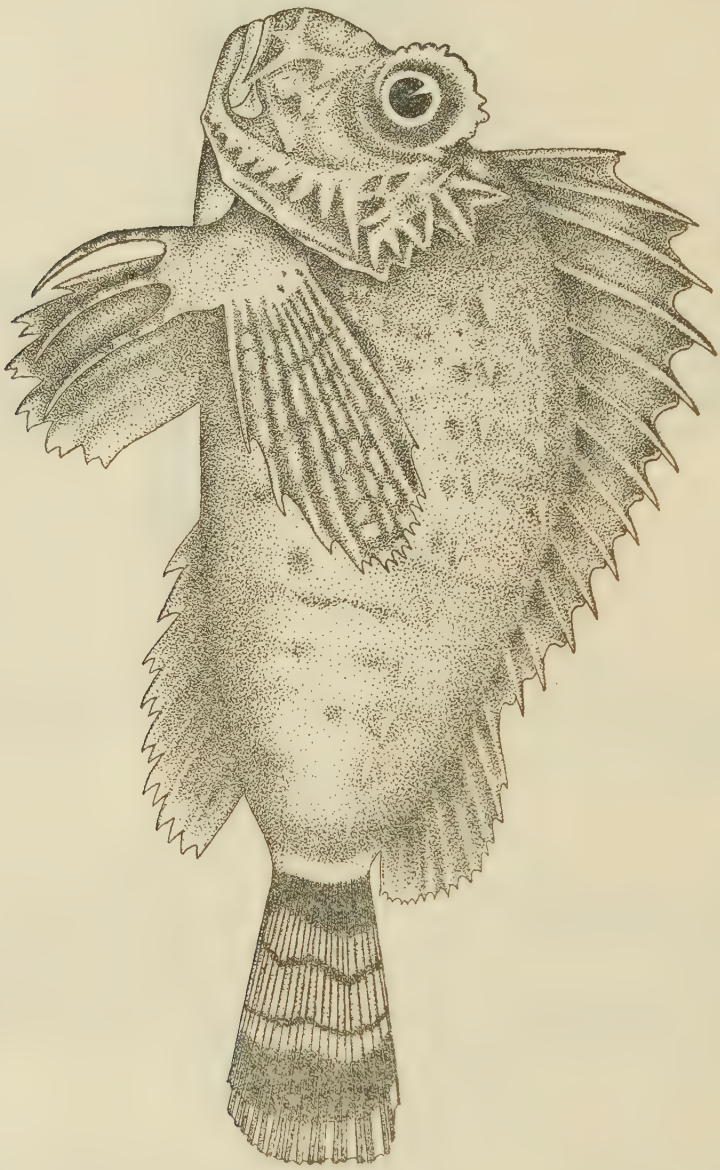

FIG. 11.

Family SYNANCEJIDÆ

Genus CHORIDACTYLUS Richardson

CHORIDACTYLUS MULTIBARBIS Richardson Fig. 11.

Two specimens, 57 and 60 mm. in length, were taken by beam trawl from Manila Bay within 8 miles of Corregidor Island, at a depth of 13 to 15 fathoms, June 27, 1947. New to the Philippines and only known previously from the coast of China and from Madras, India.

Genus INIMICUS Jordan and Starks

INIMICUS CUVIERI (Gray)

Five specimens 60 to 105 mm. in length were taken by beam trawl from Manila Bay near Corregidor Island, June 27, 1947; three more were caught in the same locality May 25, 1948. This fish has long been known from China, India, and Sumatra. This is the second Philippine record, the first being by Herre from Murcielagos Bay, Misamis Occidental Province, Mindanao, August, 1940.

Family PERISTEDIIDÆ

Genus PERISTEDION Lacépède

PERISTEDION WELCHI Herre

This species, originally described from Dumaguete, Negros Oriental Province, has since been discovered in Japan. The second Philippine specimen known was taken by the M. V. *T. N. Gill* with an otter trawl in 65 fathoms 5 miles northwest of Fortune Island, Batangas Province, Luzon, on October 2, 1947. Its length was 314 mm.

Family TRYPAUCHENIDÆ

Genus AMBLYOTRYPAUCHEN Hora

AMBLYOTRYPAUCHEN ARCTOCEPHALUS (Alcock)

Sixteen specimens 87 to 130 mm. in length were taken from Manila Bay in 19 to 29 fathoms, in the summer of 1947. This is the first Philippine record. Two examples were notable in that each had a large carcinoma on the side of the head. Previously known from the Arabian Sea, the Gulf of Martaban, the Sandheads at the mouth of the Hugli River, the Ganjam and Vizagapatam coasts of India, and the Bay of Bengal.

Genus CTENOTRYPAUCHEN Steindachner

CTENOTRYPAUCHEN MICROCEPHALUS Bleeker

Nine specimens 82 to 150 mm. in length were taken by trawl from Manila Bay between June and September, 1947, in 19 to 29 fathoms of water. This is the second Philippine record. Only the type from Borneo was known until the species was recorded

from La Libertad, Negros Oriental Province, Philippines. Also known from the Andaman Islands and the Persian Gulf.

Genus TRYPAUCHENICHTHYS Bleeker

TRYPAUCHENICHTHYS TYPUS (Bleeker)

Previously known from the Philippines by a specimen from Cagayancillo, Cagayan Islands, Sulu Sea. A second specimen 110 mm. long was taken by the M. V. *T. N. Gill,* using an otter trawl in 15 fathoms of water, 9.7 miles northwest of Sangley Point, Cavite Province, Manila Bay. The type was taken in Borneo.

Family ECHENEIDÆ

Genus REMORA Forster

REMORA REMORA (Linnaeus)

A juvenile specimen 25 mm. long was taken from a sailfish, *Istiophorus orientalis,* caught while fishing by electric light in the Celebes Sea, Lat. 6° North, Long. 123° East, between Jolo and Cotabato Province, Mindanao. The senior author later obtained half a dozen specimens at Malampaya Sound, Palawan, in June, 1948, from 200 to 500 mm. in length. A common species on many kinds of sharks and bony fishes, and on marine turtles. Long known from the Philippines, but this is the first printed record. In all temperate and tropical seas.

Genus REMOROPSIS Gill

REMOROPSIS BRACHYPTERA (Lowe)

A specimen 64.5 mm. long was taken at Lat. 5° 20′ North and Long. 123° 7′ East, Celebes Sea. It was attached to an 85-pound shark which was caught at the surface. This is the first Philippine record. Several others were taken later in the Sulu Sea and elsewhere, but the data are not available. In all warm seas, north to Japan and Massachusetts.

Family XIPHASIIDÆ

Genus XIPHASIA Swainson

XIPHASIA SETIFER Swainson

The only previous Philippine record is by Herre, from Dumaguete, Negros Oriental Province. Six additional specimens are now listed, from 5 localities. One specimen with the tail broken off but the remaining part 332 mm. long, was taken by beam trawl from Manila Bay, June 27, 1947, in 13 to 25 fathoms. The damaged specimen has dorsal rays 116, anal rays 103. A specimen 228 mm. long was taken from the stomach of a yellow fin tuna, caught in Sibutu Passage, Sulu Province. Another specimen 169 mm. long was caught from

the M. V. *S. F. Baird* while fishing with electric light in the Sulu Sea at Lat. 6° 48.5′ North and Long. 118° 51.5′ East, December 10, 1947; dorsal rays 122 anal rays 112. A specimen 236 mm. long was taken in the Sulu Sea while fishing with a light from the M. V. *T. N. Gill*, south of Pilas Island, between Basilan and Jolo Islands, April 13, 1948. Two specimens 230 and 247 mm. in length were purchased in the Batangas market, Batangas Province, Luzon, April 20, 1948. This fish is known from India to the Riu Kiu Islands.

Family CHÆNOPSIDÆ

Genus PHOLIDICHTHYS Bleeker

PHOLIDICHTHYS LEUCOTAENIA Bleeker

Two specimens of this very rare blenny, 111 and 123 mm. in length, were taken from Candaraman Inlet, off Albay Island, northeast of Balabac Island. They were caught by the aid of electric light, December 7, 1947.

Dorsal rays 75 and 77; anal rays 61; pectoral rays 14 on the smaller one, 15 on the larger; caudal rays 10. Depth 8.1 and 8.78, the head 6 to 6.9 times in the length. The snout is 4.94 to 5.14 times, the eye 5.96 to 5.56 times in the head. The smaller specimen has the following measurements: depth 13.7 mm.; head 18.5 mm.; snout 3.6 mm.; eye 3.1 mm. The other has the depth 14 mm.; head 17.8 mm.; snout 3.6 mm.; eye 3.2 mm.

New to the Philippines and only known previously from the island of Buru, Dutch East Indies.

Family CARAPIDÆ

Genus CARAPUS Rafinesque

CARAPUS PARVIPINNIS Kaup

Two examples, 125 and 315 mm. in length, were taken from a holothurian in 10 fathoms of water at Musa Bay, Fuga Island, Babuyanes Islands north of Luzon. First Philippine record. Widely distributed in Polynesia, ranging from the Society Islands to the Philippines.

Family MONACANTHIDÆ

Genus CANTHERINES Swainson

CANTHERINES TESSELLATUS Gunther

A specimen 147 mm. long was taken by otter trawl operated from the M. V. *T. N. Gill*, October 2, 1947, at a depth of 65 fathoms, off the west coast of Cavite Province, Luzon, outside the entrance to Manila Bay. This is the second Philippine record. The first record was by Günther in 1880; his specimen

came from Banton Island in the Sibuyan Sea, Romblon Province. These two specimens are the only ones known.

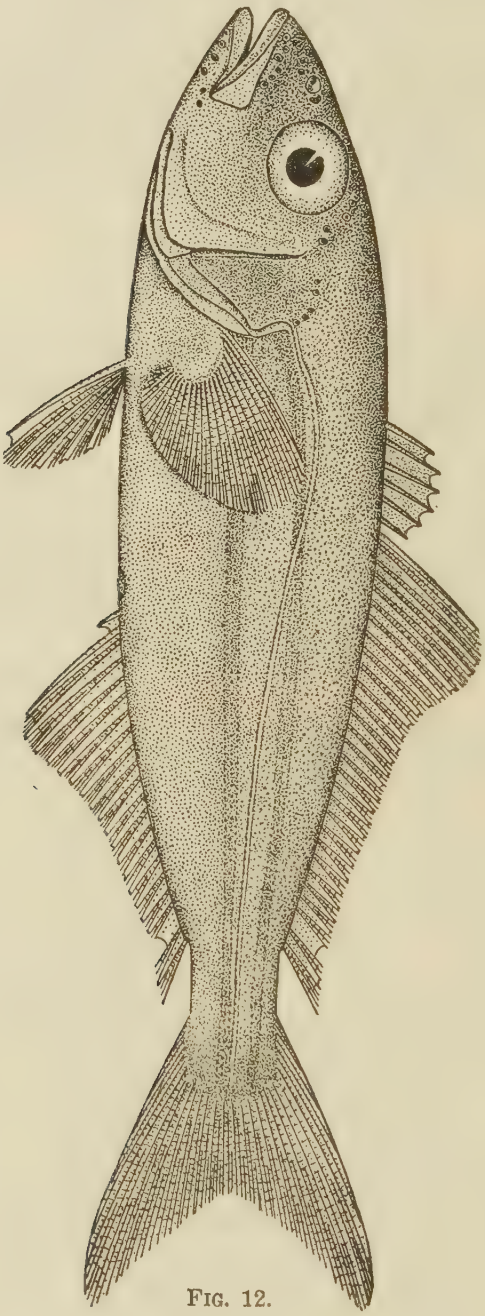

FIG. 12.

APPENDIX

NOTEWORTHY FISHES FROM AREAS ADJACENT TO THE PHILIPPINES

Family SCOMBRIDÆ

Genus SCOMBEROMORUS Lacépède

SCOMBEROMORUS KUHLII Cuvier and Valenciennes

One specimen 330 mm. in length was purchased in the market at Sandakan, British North Borneo on January 11, 1948. Since this locality is within a very few miles of Philippine waters, this species may undoubtedly soon be added to the Philippine Checklist. Munro has indicated in his revision of *Scomberomorus* (1943, p. 68) that *Scomberomorus guttatum* Kishinouye which has previously been recorded from other sections of Borneo is actually a synonym of *S. kuhlii*. Pertinent data on this specimen are as follows: dorsal XVI-20-9; anal 19-8; gill rakers 2 + 1 + 7 =10.

Family CARANGIDÆ

Genus ELAGATIS Bennett

ELAGATIS BIPINNULATUS Quoy and Gaimard Fig. 12.

At a Celebes Sea nightlight station, Lat. 2° North, Long. 123° East, there was obtained a 40 mm. fish which upon examination proved to be the youngest specimen known of this species. Even on this small specimen the blue and yellow lines which are so prominent on the adult rainbow runner, were vividly present. It will be noted that the characters of this juvenile fish are quite different from those of the adult. Although "salmon", as they are known in some parts of the Philippines, are quite common, the younger stages have not previously been available.

ILLUSTRATIONS

FIG. 1. *Umalius philippinus* n. g. and sp.; 126 mm.
2. *Diplophos tænia* Günther; 36 mm.
3. *Trachypterus misakiensis* Tanaka; 90 mm.
4. *Jordanidia prometheoides* (Bleeker); 168 mm.
5. *Istiophorus orientalis* Schlegel; 159 mm.
6. *Xiphias gladius* Linnæus; 41 mm.
7. *Nomeus gronovii* (Gmelin); 30 mm.
8. *Coryphæna equisetis* Linnæus; 19 mm.
9. *Howella brodiei* Ogilby; 58 mm.
10. *Histiopterus typus* Schlegel; 120 mm.
11. *Choridactylus multibarbis* Richardson; 57 mm.
12. *Elagatis bipinnulatus* Quoy and Gaimard; 40 mm.

SIX ADDITIONS TO THE PHILIPPINE FISH FAUNA, INCLUDING TWO NEW SPECIES

By Albert W. Herre
School of Fisheries, University of Washington

Further studies of my 1948 Philippine collections continue to make surprising additions to our knowledge of Philippine fishes. The specimens mentioned here were taken from Manila Bay, the Batangas coast, and Dumaguete. It was supposed that the fish fauna of Manila Bay was well known, but trawling near the entrance to Manila Bay has revealed many kinds of fishes whose presence was not suspected. When similar investigations are made in Ragay Gulf, the Gulf of Lingayen, and among the islands north of Luzon, we may expect many more additions, especially of fishes now only known from more northern waters.

PSENES EXTRANEUS Herre, new species

First dorsal XI; second dorsal II—14; anal III—15; pectoral 22; scales in lateral line about 55 but owing to their deciduous character the number is uncertain; gillrakers 6 plus 14.

The laterally compressed ovate body has the upper and lower profiles about evenly convex; the head is strongly convex, snout descending steeply to the small mouth; the lower jaw is projecting, the maxillary not extending to the eye. The depth is 2.4, the head 3.1, the pectoral 3.44 times in the length. The circular eye is 3.4, the short snout 3.8, the high convex interorbital 3.1 in the head. The preopercular margin is entire, the opercle without a definite spine. The first dorsal spine is very short and rather stout, the others all weak with elongate flexible tips; the fourth and fifth spines longest, a trifle more than half as long as the head or 6 times in the total length; first spine of second dorsal stout and very short, 3 times in the eye; second spine long, slender, 3.1 in head and higher than any of the dorsal rays. First 2 anal spines short and stout, the third much longer but weak, the anal rays like those of the dorsal. The basal half or two-thirds of the second dorsal and anal are covered with skin, leaving only the tips of the rays free. The pectoral extends to above the third anal ray. The ventral origin is definitely a little behind that of the pectoral; the ventral is 7.4 times in the length, its tip scarcely reaching

the anus. The caudal is too badly broken to make measurements, but it was evidently deeply forked. The small scales are very deciduous, those of the lateral line larger and plate-like; scales cover the basal half of the second dorsal and anal fins.

The color is more or less purplish gray, becoming yellowish on the head, with 6 vertical dusky cross bars, the first descending from the back to behind the pectoral, the last on the caudal peduncle; besides these there are dusky spots and irregular marks; the opercle is largely covered by a purplish black spot. The scales are silvery, and in life the whole fish must have had a brilliant silvery sheen. The dorsal and anal membranes are black or blackish; the pectorals are colorless, the caudal and ventrals yellow.

Here described from the type and sole specimen, 97 mm. long, purchased in the Batangas market and caught in Batangas Bay, Batangas Province, Luzon. It is almost scaleless and was badly handled by the fisherman, so that it is in poor condition. It is evidently closely related to *Psenes indicus* (Day). A large series might show it to be only a variation of *P. indicus*, but until more material is available the present disposition must stand. *Extraneus*, a stranger.

CHELIDOPERCA HIRUNDINACEA (Cuv. and Val.)

Centropristis hirundinaceus Cuv. and Val., Hist. Nat. Poiss. 7 (1931) 450, Japan; Schlegel, Fauna Japon., Poiss. (1842) 14, *plate 5, fig. 1*, Nagasaki.

Centropristis pleurospilus Günther, Reports *Challenger* Expd., Zoology 1 (1880) 37, *plate 16, fig. D*, part VI, Shore Fishes, Ki Islands.

Chelidoperca hirundinacea Boulenger, Cat. Fishes, ed. 2 1 (1895) 305, Japan and Arafura Sea, off the Kei Islands, Jordan and Richardson, Proc. U. S. Nat. Mus. 37 (1910) 464, Suruga Bay and Sagami Bay, Japan; Tanaka, Fishes Japan 12 (1912) 343, *plate 92, figs. 296–297*, Nagasaki to Tokyo

Known from Japan and the Ke Islands, south of New Guinea.

Three specimens of typical appearance, 53 to 105 mm. in length, were taken in the south entrance to Manila Bay. I find they do not agree with Boulenger's description, but are nearer to Günther's account cited above.

Dorsal X—10; anal III—6; scales 42 to 44, 3 or 3½ above and 11 or 12 below the lateral line; pectoral I—14, as in Günther's figure, not 17 as in Boulenger. Gillrakers 3 to 5 plus 8 or 9, with 4 more low rounded rudiments.

Color of preserved specimens reddish tan, with faint indications of 5 or 6 dorsal cross-bands; a row of 5 conspicuous black oblong spots above the middle of the side; in the smallest specimen they form an almost continuous line. There are faint traces of darker cross-bars on the spinous dorsal, the fins otherwise clear. Immediately behind the eyes is a conspicuous circular yellow spot. This species is apparently red in life.

With the above I place a specimen 71 mm. long, of uniform coloration, without the row of spots so conspicuous on the others. It also has a peculiar physiognomy; the snout is shorter and concave, instead of convex, as in all other specimens. The anterior teeth of the upper jaw project forward, and are exposed when the mouth is closed. Scales 42, with 2 above and 9 below the lateral line. The gillrakers are 2 plus 6.

In his generic diagnosis Boulenger mentions teeth "in the middle of the upper jaw enlarged, depressible, hinged at the bases. The enlarged teeth are conspicuous in all my specimens, but the teeth are fixed, not hinged or depressible.

NEMIPTERUS BALINENSIS (Bleeker)

Dentex balinensis Bleeker, Nat. Tijds. Ned. Ind. **17** (1858–59) 155, Boleling, Bali; Bleeker, Atlas Ichth. **8** (1876–77) 95, *plate 327 fig. 4*, Bali.

Synagris balinensis Fowler, U. S. Nat. Mus. Bull. 100, **12** (1933) 103, after Bleeker.

Nemipterus balinensis Weber and de Beaufort, Fishes Indo-Austr. Arch. **7** (1936) 385, Bali.

A very rare East Indian species now made known from the Philippines for the first time.

I refer here a specimen 84 mm. long, taken off the coast of Cavite Province, Luzon, in the south entrance to Manila Bay. It was dredged in about 60 fathoms.

Dorsal X—9; anal III—7; scales in lateral line 47, plus 2 or 3 on the caudal base; 3 above and 10 below the lateral line; gillrakers 5 + 12.

The depth is 3.9, the head 3.23, the caudal 4 times in the length, omitting the filament on the upper lobe of the caudal. The large eye is 2.8, more than the blunt snout, which is 3.7 in the head or 1.4 times in the eye. The flat interorbital space is rather wide, 1.5 in the eye. The maxillary reaches to beyond the front margin of the eye, 3 times in the head. Small caniniform teeth in the upper jaw, but none in the lower jaw. The suborbital is very narrow, its depth 4.5 times in the vertical diameter of the eye. The hind border of the preoperculum

is plainly denticulate. The dorsal spines are rigid and sharp, the membrane between them scarcely emarginate; the soft dorsal rays approximately equal to the spinous part in height. The pointed pectoral is nearly 5 times in the length, its upper middle rays longest. The upper lobe of the deeply forked caudal ends in a filament, as in Bleeker's figure.

The color in alcohol is reddish brown, with a yellow band about as wide as the pupil along the middle of the side; fins colorless.

Bleeker's type was 151 mm. long.

Bali is the only other locality where this fish has been taken.

EVIOTA DISTIGMA Jordan and Seale

Eviota distigma Jordan and Seale, Fishes Samoa, Bur. Fish. Bull. 25 (1906) 389, *fig. 79*, Pago Pago, Samoa; Fowler and Silvester, Marine Papers Carnegie Inst. (1922) 125, Pago Pago; Fowler, Fishes Oceania, Mem. Bishop Mus. 10 (1928) 395, Pago Pago; Herre, Zool. Ser. Field Mus. Nat. Hist. 21 (1936) 348, Papeete, Tahiti; reef near Suva, Fiji.

Originally described from Samoa and widely distributed in Polynesia. Now reported for the first time from the Philippines.

A specimen 15 mm. long of this obscure little inhabitant of coral crevices was taken from a coral head at Dumaguete, Negros Oriental Province.

NEOPERCIS TESSELATA Herre, new species

Dorsal V—22; anal 18; scales in the lateral line 58 plus 4 or 5 on the caudal base, 5 above and 12 below the lateral line.

The breadth of the slender elongate body equals or is slightly more than the depth, which is 6.88 times in the length. The head is large, 3.25 in the length. The elongate convex snout is 3.27 in the head, the lower jaw protruding. The eye is prominent, impinging on the upper profile, 3.6, the maxillary 2.57 times in the head. The interorbital is 2.22 in the eye or 8 times in the head. The mouth is large, the maxillary extending beneath the anterior third of the eye; 2 strong curved canines at the front of the upper jaw and four in the lower jaw. Pectoral somewhat rounded, 5.57, the nearly truncate caudal 5.85 times in the length; the ventral reaches the anal. All scales are ctenoid.

Spinous and soft dorsals deeply divided, the fourth spine longest, 4.5 in the head; soft dorsal rays of nearly uniform height, middle and posterior rays 2.57 times in the head; anal

of nearly uniform height, a little lower than the soft dorsal, longest rays 3 in the head. Least depth of the caudal peduncle 1.25 times in its own length or 4.5 in the head.

Color in alcohol reddish brown, with traces of 5 (6?) broad double blackish cross-bands over the back and sides; each scale above the lateral line is margined with black, giving a tessellated appearance; a dusky spot above the middle of the caudal base and the posterior fourth of the middle caudal rays blackened; spinous dorsal vaguely barred with darker; fins otherwise colorless, though the soft dorsal has indications of having been lightly barred.

Herre described from the type and only specimen, 117 mm. long, taken by commercial trawl in Manila Bay, 16 kilometers north-east of Corregidor. This is the first Philippine record of the genus *Neopercis*, distinguished by having teeth on the palatines.

Tessellatus, checkered, in allusion to the appearance of the back.

CHAMPSODON ARAFURENSIS Regan

Champsodon arafurensis Regan, Trans. Linæan Society, ser. 2, Zoology 12 (1908) 245, "Arafura Sea and Ki Islands", at 129 fahtoms; Weber, Max *Siboga* Exped. Fische 57 (1913) 146, Madura Strait and Sea; Bima; Buton Strait; Timor Sea; near Waigiu.

Originally known from the Arafura Sea and Kei Islands, and later from the East Indies, it is now reported from the Philippines for the first time. Lives on sandy and muddy bottom.

Taken at various depths from 8 meters to 141 meters.

First dorsal IV or V; second dorsal I—19 to II—17; anal I—17 or 18? Gillrakers 2 + 8 to 10.

Depth 4.8 to 5.5, head 3.4 to 3.6 times in the length. The eye is 4.8 to 5 times in the head and is more than the interorbital. The maxillary extends well beyond the eye, its length 1.75 to 1.5 times in the head. The ventrals extend to the origin of the anal. The preopercular spine does not extend to the ventral origin. Between the occiput and caudal are about 24 transverse lines which are branches of the two lateral lines.

The color in alcohol is reddish brown, the back and sides often more or less sprinkled with black dots. In the smallest specimens these form 5 or 6 short transverse black bands over the back, the bands disappearing with age. Some specimens also have the abdomen sprinkled with black dots. When spec-

imens are removed from alcohol and dried a little the scales become brilliant silvery, while the transverse lines become conspicuous, the longitudinal lateral lines less evident.

Six specimens, 31 to 50 mm. in length, were taken in the south entrance to Manila Bay, off the coast of Cavite Prov., in 65 fathoms. A specimen 48 mm. long was much bulkier than any others. A specimen 56 mm. long was taken in Manila Bay, in 17 to 25 fathoms, about 10 miles northeast of Corregidor.

Descriptions of ten species of *Champsodon* have been examined. Several of them are very close and their status is doubtful. They need to be revised with ample material available for comparative study. In that event several would probably be relegated to synonymy. The above disposition is not completely satisfactory, but is the best that can be made at present.

BOOKS

Books reviewed here have been received by The Philippine Journal of Science from time to time and acknowledged in this section.

REVIEW

Analytic geometry. By Clyde E. Lowe. 4th ed. New York, The Macmillan company, 1948. 306p., illus. Price ₱7.00.

The author is a well-known professor of mathematics and his text should receive the attention of teachers on his favorite subject. Analytic Geometry is presented as stated in the preface "to make the text easier reading for the student". In it the author proves well his objective. It is doubtful whether any book on the subject could be written with such clearness and conciseness without sacrificing any of the important parts.

The chapters covered are those usually found in any textbook of this nature. There are others, like Chapters IX, XVI and XVII which increase the usefulness of the text. The book is not only an excellent text for a course in analytic geometry but also a good reference for those who already took the subject and wish to refresh their knowledge of the subject.—G. O. O.

Calculations of quantitative analysis. By Philip W. West. New York, The Macmillan company, 1948. 162p. Price ₱5.50.

In this book the author had in mind to impart to the student a thorough training in the methods of analytic calculations which provides in turn a more fundamental understanding of the underlying principles of the various analytical determinations studied. The book was written in lecture style and sufficient examples are included to enable the student to see how each typical problem should be approached. The problems selected were chosen from standard elementary quantitative chemical analysis text-books, some of which have direct bearing on industrial applications from such fields as metallurgy, geology and water analysis. Likewise sufficient information is given to enable the student to understand the principles of the determinations involved and the nature of the procedures. This book is certainly a tool for an easy grasp on this practical branch of chemistry.—L. G. A.

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